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REPORT

OF THE

COMMISSIONER OF CORPORATIONS

ON

WATER-POWER DEVELOPMENT IN THE UNITED STATES

PART I. PHYSICAL CONDITIONS AND ECONOMIC ASPECTS OF WATER POWER.

PART II. CONCENTRATION OF OWNERSHIP AND CONTROL.

PART III. WATER POWER AND THE PUBLIC.

PRINTED IN 1911

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U. S. Bureau of Corporations

March 14, 1912

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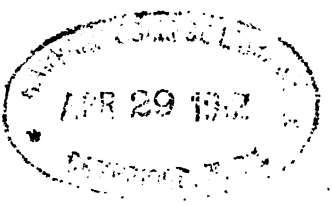

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LETTERS OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
OFFICE OF THE SECRETARY,
Washington, March 14, 1912.

SIR: I have the honor to transmit herewith a report of the Commissioner of Corporations on Water-Power Development in the United States.

Respectfully,

CHARLES NAGEL,
Secretary.

The PRESIDENT.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF CORPORATIONS,
Washington, March 14, 1912.

SIR: I have the honor to transmit herewith a Report on Water-Power Development in the United States.

I desire to mention as especially contributing, under my direction, to the preparation of this report the name of Mr. Thomas M. Robertson, one of my assistants.

Very respectfully,

HERBERT KNOX SMITH,
Commissioner.

To Hon. CHARLES NAGEL,
Secretary of Commerce and Labor.

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LETTER OF SUBMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF CORPORATIONS,
Washington, D. C., March 14, 1912.

SIR: I have the honor to transmit a Report on Water Power Development in the United States.

Within the last decade, through the development of electric transmission of power, our water-power resources have come into national importance. Power from a single source can now reach a marketing area of at least 100,000 square miles. Water power, once strictly local, has thus suddenly been brought within the sweep of large economic forces. This report shows the results:

(1) An increasing concentration of the control of water powers by certain large interests.

(2) Extensive relationship between water-power interests, public-service companies (street railway, lighting, and power concerns), and banks.

(3) The need of developing our water powers as promptly and completely as practicable. Use of water power means conservation of fuel.

(4) The need for a definite public policy with respect to water powers. The effective means of applying such policy is through the control of the power site. It can not be applied through fixing the price of water power independently of fuel power.

Total developed and potential water power.—The total stationary power now used in the United States—steam, water, and gas—is probably over 30,000,000 h. p. ("h. p." means horsepower). Our total developed water power is about 6,000,000 h. p. The Bureau considered only developments of 1,000 h. p. and over. These amount to about 4,000,000 h. p., and three-fourths of this is "commercial power" (power produced for sale). Unless otherwise stated, the power discussed herein is all "commercial," and is developed power (i. e., either actually installed or under construction).

Our water power now economically capable of development probably does not exceed 25,000,000 h. p., including that already developed. Any such estimate is, however, necessarily approximate. The total developed and undeveloped is mainly in the Far Western States, the Lake States, and certain Atlantic Seaboard States.

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Concentration forces.—There are three main causes of the consolidation of water powers.

First, economy in operation. A small water power, operated independently, rarely justifies the large investment usually necessary in transmission and distributing lines; but by "coupling up" several powers on the same transmission lines their use often becomes practicable.

Again, "coupled" power sites can supplement each other. One plant, lying idle in hours of low demand, can accumulate reserve "pondage" of water while the other serves the market.

Furthermore, the demand for power made upon a given power system usually comes from several different sources (lighting, traction, manufacturing, etc.), the requirements of which are not uniform during the day. The maximum of this total, usually reached late in the afternoon, is known in engineering parlance as the "peak of the load." The power system must be large enough to meet this "peak"; but if so, then during the rest of the day some part of the plant will be idle. Consequently, the nearer and more constantly the power demand approaches that maximum the more fully will the entire fixed investment in the plant be earning a return. By uniting different power markets much greater uniformity in this power demand is often obtainable and is obviously desirable.

Second, specialization in engineering enterprise. In this comparatively new field the expert knowledge of a few engineering, electro-equipment, and financial concerns tends toward dominance by such concerns.

Third, the elimination of competition. There is less opportunity for competition in water power than in most industries. For example, Michigan powers, obviously, can not compete in South Carolina. In considerable areas, however, the opportunity to eliminate competition by controlling the best power sites and the chief consuming interests is undoubtedly a factor in bringing about concentration of water powers.

Nor is this all. Water power also tends to become the nucleus for a monopoly of both water and steam power. The great transmission and distributing systems necessary for important water powers are in themselves a naturally monopolistic factor. They are not likely to be duplicated by fuel-power producers. The water-power owners, on the other hand, if the water power can not meet the entire power demand of the given locality, can construct or acquire auxiliary fuel plants and handle this power over the same distributing lines, and thus gradually build up a complete commercial power monopoly. Such, indeed, are the existing facts in a number of communities.

The actual effect of these great forces is now everywhere apparent.

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Local concentration.—In California six great power corporations, of which the most important is the Pacific Gas & Electric Co. (with 118,343 h. p.), together control 375,000 h. p., over 86 per cent of all the developed water power in the State.

In Washington two companies control 210,000 h. p., or about 70 per cent of all developed water power.

In South Carolina the Southern Power Co. owns about 101,000 h. p., or 75 per cent of the total commercially developed, with 73,000 h. p. undeveloped.

In the Southern Peninsula of Michigan the Commonwealth Power, Railway & Light Co. controls 52,000 h. p., or 73 per cent of the commercially developed, together with probably 71,000 h. p. more undeveloped.

Practically similar conditions exist in Montana, Colorado, Georgia, and at Niagara Falls.

Control by interests.—More important still, however, are the great groups of water-power interests. There are 10 groups of interests each controlling, or influencing through mutual directors and officers, over 50,000 h. p., developed and under construction. By far the widest sphere of influence is that of the General Electric Co., primarily an electric-equipment concern. The General Electric influence takes three forms: First, by absolute control; second, through interownership of stock and community of directors; third, simply community of directors. In the first class there are six companies, with about 83,000 h. p.; in the second class 8, with 419,000 h. p.; and in the third class 10, with 437,000 h. p.; a total of 939,000 h. p. of developed water power in 18 different States. In addition, this group controls about 640,000 h. p., undeveloped, a grand total of over a million and a half horsepower.

Next are the Stone & Webster interests, which own or strongly influence 278,000 h. p., chiefly in connection with public-service concerns. They exercise control, largely through management rather than ownership, over 55 or 60 companies. Eight have water power, the largest being on the Mississippi River and in the Puget Sound region.

The other groups are the Hydraulic Power Co. of Niagara Falls, 144,000 h. p.; the Pacific Gas & Electric Co., with over 118,000 h. p. developed and the dominating factor in a large portion of California; the group known as the Clark-Foote-Hodenpyl-Walbridge interests, 104,000 h. p., largely dominating the water-power situation in Michigan and also active in Maine and Oregon; the Southern Power Co., 101,000 h. p., which owns the great bulk of the commercially developed power in South Carolina; the S. Morgan Smith interests (Georgia), 76,000 h. p.; the Brady interests (Tennessee), 70,000 h. p.; the United Missouri River Power Co., 65,000 h. p., which, with the

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Butte Electric Power Co. (General Electric group), practically dominates the power situation in Montana; and the Telluride Power Co. (Colorado, Idaho, and Utah), 56,000 h. p. These last-named nine interests also include under their influence 887,000 h. p. undeveloped.

Thus 10 interests, excluding duplication, control or strongly influence 1,821,000 h. p. developed water power, about 60 per cent of the total commercial power in the United States, together with 1,449,000 h. p. undeveloped.

Interrelationship of large interests.—There is a still wider community of interest. Some of these great groups show more or less relationship with each other. The two greatest, the General Electric and the Stone & Webster groups, have directors in a number of the same corporations, and the S. Morgan Smith, Westinghouse, and Brady interests are similarly connected.

Water-power and public-service companies.—There is, furthermore, an increasing affiliation of water-power concerns and public-service companies. The companies in the General Electric group control street railways in 16 towns, electric-lighting plants in 78, and gas plants in 19. Altogether, water-power or allied companies own or control and operate street railways in 111 towns, electric-lighting plants in 669 towns, and gas plants in 113 towns.

The reasons for this are obvious. Control of the chief consumers of power both assures a market for power and excludes others. This connection between great power groups and the agencies that directly serve the public is of serious public significance.

The whole concentration movement is still going on. This report has, as far as possible, been brought up to date, but since it went to press new mergers have occurred.

Interlocking directorates.—A more general relationship, of a sort not peculiar to water power, but nevertheless of broad public significance, is best illustrated in the General Electric Co. Men who are officers or directors in that company, or of its three wholly controlled subsidiaries, are also officers and directors in many other corporations. These other companies, with their subsidiaries, and with the General Electric and its subsidiaries, make a far-reaching group thus interconnected by active personal and financial relationship. This one group of interrelationships controls or influences 24 corporations that operate hydroelectric plants; over 50 public-service corporations, not counting as many minor subsidiaries; and, finally, this one group of interrelationships includes numerous railroad and industrial corporations, and over 50 banks and financial houses, many of them in the first rank of importance. About 20 "General Electric" men in all constitute most of this chain of connection, three of these being members of the firm of J. P. Morgan & Co., which is generally regarded as the dominant interest in the General Electric

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Co. These connections in no sense always mean control by the General Electric Co., or even identity of policy. They do, however, mean a striking degree of community of interest.

Resulting public issues.—This great concentration movement is in a field where the public is peculiarly interested. Power is at the foundation of modern industry. The facts raise these questions: (1) The best development of our water-power resources; (2) the protection of the consumer; (3) the securing for the whole public of its proper share in the advantages inherent in the natural resource itself.

The need for water-power development is obvious. The nonuse of water power means the diminution of our other sources of power. The water power now in use saves at least 33,000,000 tons of coal annually.

Prompt utilization is therefore essential. But it must be frankly recognized that the most efficient use of water power requires a considerable degree of unified control. Certain highly monopolistic tendencies are inherent in the water-power industry, largely centering around the expensive fixed investment in transmission and distributing lines.

Our public policy must recognize both the need for utilization and the dangers of monopolistic control and take effective action on both. It must also recognize the close relation and possible conflict between water power, navigation, and irrigation.

One very important fact must be emphasized. The point at which such effective public policy must be applied is the power site itself. The public can not be protected by any attempt to fix by law the selling price of water power *by itself*. Nor can any such method secure for the public its due share in the natural resource. Fuel power will substantially fix the price of all power, because there is practically no considerable area in the United States where water power can supply the entire demand for power. Of course, water power can not be sold above the price of fuel power. On the other hand, if the price of water power be fixed by law below that of fuel power, not all the community, in most instances, can be served with the cheaper power, and an unfair discrimination must result. If we take water power by itself, there is, broadly speaking, but one effective method of control, in so far as the power sites are still public property. The public can either develop and operate the site, selling the energy at market rates, or the public may lease the site at a rental fairly representing its natural value. In either case the public treasury will get the profit due to that natural value. There may be certain exceptional instances which would justify the outright sale of public power sites. The rental system, however, presents distinct advantages—foremost of all, that of retaining in the public

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hands the ultimate control of the resource. Assured public control is peculiarly desirable, because, broadly speaking, water power is inexhaustible and permanent, and therein differs from almost all the other natural resources, which are expended in their using.

Finally, whatever form of public action is taken, that action should be immediate—first, to save our fuel by the use of water power, and, second, because our remaining public water powers are fast passing into private control, making regulation thereafter difficult.

Very respectfully,

HERBERT KNOX SMITH,
Commissioner of Corporations.

The PRESIDENT.

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REPORT OF COMMISSIONER OF CORPORATIONS ON WATER-POWER DEVELOPMENT IN UNITED STATES.

SUMMARY.

This report deals with developed water power in the United States, the ownership or control of such power, and the fundamental economic principles involved in its utilization. It is particularly concerned with "commercial power"—that is, power generated for sale, rather than with power generated by manufacturers for their own use. A brief discussion of the potential water power of the country is also included.

The report shows the following important facts:

1. A rapid development of water power in recent years.
2. A rough estimate of the potential water power of the country, together with the popular exaggeration of such power.
3. A marked local concentration of water power.
4. An increasing concentration of the ownership and control of developed water power of several localities in a few hands.
5. A substantial interrelationship among leading water-power interests.
6. A significant and increasing affiliation between water-power companies and street-railway and electric-lighting companies.
7. The importance of the prompt adoption of a definite public policy with respect to water-power development.

PHYSICAL FACTS INVOLVED.

Prior to the discovery of electrical transmission of power over long distances, water power could be utilized only at the power site. This limited its development in most cases to comparatively small units, and almost exclusively to manufacturing enterprises. The introduction of electric-power transmission not only provided a means of supplying distant manufacturing and domestic demands, but also opened up an entirely new power field, namely, the operation of street railways and lighting plants, and enormously increased the relative importance of water power. Thus the development of water power (based on installed wheel capacity) for railway and lighting purposes increased from 487,000 h. p.[1] in 1902 to 1,441,000 h. p. in

[1] The abbreviation "h. p." is used throughout to denote "horsepower" wherever the word appears in connection with figures.

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1907 (the latest date for which statistics are available), or by nearly 200 per cent. In manufacturing industries, where transmission by electricity is infrequent, water-power development during the period 1900–1905 increased by only 11 per cent.

These comparisons suggest the remarkable influence that electrical transmission has had upon the development of water power in recent years, and at the same time they indicate the peculiarly close natural relationship between the water-power industry and public-service enterprises.

This growing importance of the "commercial" use of water power, its comparatively recent development and the consequent lack of an appreciation of its real significance, together with the established connection between commercial water-power enterprises and public utilities, all demand that the public be furnished with accurate and comprehensive information on this subject. This report is an attempt to meet that demand.

POTENTIAL WATER POWER IN THE UNITED STATES.

This report deals particularly with developed water power. The Bureau has made no direct investigation as to the total undeveloped power. Various estimates have been made, but most of these are but little better than mere guesses.

The most comprehensive estimates are those prepared by the United States Geological Survey for the National Conservation Commission in 1908. Though the most reliable that have been made, they are necessarily approximate, owing to lack of data. Even where actual measurements of flow and fall are made, certain important factors are indeterminable, and without such measurements there is still greater liability of error.

Furthermore, much water power, though physically available, is not within the range of present economic possibilities, on account of the distance from markets or for other reasons. Still again, water available for power may often be more valuable for irrigation or for domestic purposes.

ESTIMATES OF POTENTIAL POWER.—The United States Geological Survey estimated the "minimum potential" water power of the country at 36,916,250 h. p., and the "assumed maximum" at 66,518,500 h. p., both figures excluding storage possibilities. "Storage," as used in this report, means the extensive storage of water in large reservoirs so as to regulate the stream flow over considerable periods. It does not refer to the small accumulation of water in a power dam; this is referred to as "pondage."

These Survey estimates of potential power were arrived at by multiplying the flow of the stream into 90 per cent of the fall. The "minimum" power estimates of the Survey are based on the flow of

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streams for the two lowest 7-day periods in each year for seven years or less. It is obvious that such a minimum must be decidedly higher than the absolute minimum for the lowest day, or for a single consecutive 7-day period, or a smaller number of days. Obviously, also, the Survey's use of averages for two 7-day periods yearly over a period of seven years may omit the absolute minimum entirely. Any probable error in the estimate of the minimum, however, is not important, since it is always practicable to develop considerably more than the minimum.

In computing its "assumed maximum" power figures, the Survey based its estimates upon the continuous power indicated by the flow of a stream for the six months of the year (not necessarily consecutive) showing the highest flow. The average flow for the lowest week of the lowest month of these six highest months was taken as the assumed maximum for that year. The yearly averages thus obtained were then themselves averaged for a series of years. In actual engineering practice the continuous power of the nine months showing the greatest flow is frequently used as a basis for determining the amount of water-power installation. Of course, as the number of highest months is increased, the indicated maximum power is reduced.

Obviously the maximum flow for a short period usually can not be economically developed. A large part of the equipment thus installed would be useless in periods of low water. There are some rare exceptions to this rule, and streams are sometimes overdeveloped.

Revision of Survey figures.—The Survey estimates require some revision. They do not include any power for Pennsylvania (because data were not at the time available). For Pennsylvania there must be added 331,000 minimum h. p. and 821,000 h. p. assumed maximum. On the other hand, the Survey estimate includes 5,800,000 minimum h. p. and 6,500,000 maximum h. p. for Niagara Falls. Under a treaty between the United States and Great Britain, only about 25 per cent of this theoretical horsepower can be developed, and only five-fourteenths of the power made available thereby belongs to the United States, its share being reduced because of the diversion of water from Lake Michigan into the Drainage Canal at Chicago. There is therefore left at Niagara Falls a minimum of only 518,000 h. p. that can be developed on the American side. Making these revisions for Pennsylvania and Niagara Falls and some minor revisions of clerical errors, the figures of the Survey for the entire country would be 32,083,000 and 61,678,000 minimum and maximum h. p., respectively.

Furthermore, the estimates of the Survey are based upon the assumption of 90 per cent efficiency of power on the turbine shaft, which is taken to be the probable future efficiency of hydraulic equip-

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ment. An efficiency of 75 per cent is more fairly representative at present. Reducing the estimates of the Survey accordingly, the totals become 26,736,000 h. p. and 51,398,000 h. p., minimum and maximum, respectively.

The Survey figures also contain another factor of overestimate, by using 90 per cent of the fall between two given points on a stream. It is seldom possible to obtain 90 per cent of the total fall in actual development.

It is probable that even with the reductions above noted the Survey figures still exaggerate the potential water power of the country. Obviously it is impossible to estimate the extent of this exaggeration.

STORAGE POSSIBILITIES.—As noted above, no allowance for storage has been made in these Survey estimates. Various estimates including storage have been made, but most of them are exceedingly extravagant, and none of them is based upon sufficiently reliable data to warrant unquestioned acceptance. The difficulties in estimating possible power development are multiplied if storage is involved. Such storage estimates as have been made are discredited by their exceedingly wide variations. For example, one authority allows California 11,400,000 h. p., while another allows it only 5,000,000 h. p. One estimate gives New York, Maine, California, Oregon, and Washington a total of 34,000,000 h. p., while others give 17,000,000 h. p. Any estimate including storage must be mainly theoretical, and may give results far in excess of actual possibilities.

The water-power centers of the country are the Pacific coast and intermountain States, the New England States and New York, the Great Lakes region, and the States entered by the southern Appalachian Range. Approximately 43 per cent of the total estimated minimum power of the country is found in California, Oregon, and Washington. Adding to this the power in Montana, Wyoming, and Idaho gives 60 per cent of the total minimum power in these six States.

POWER DEMAND.

The total installed stationary prime-moving power of all kinds (steam, gas, and water) in the United States in 1905–1907 (the latest date for which complete statistics are available) was approximately 23,000,000 h. p. Of this, 18,858,000 h. p., or 82 per cent of the total, was generated from steam; 3,423,000 h. p., or 15 per cent, was developed from water; while 631,000 h. p., or about 3 per cent, was generated from internal-combustion engines. It will be seen, therefore, that only about one-seventh of the total power demand of the country was at that time supplied by water. It seems highly probable that the rapid development of water power since 1907 has increased its proportion of the total installed prime-moving power.

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DEVELOPED WATER POWER IN THE UNITED STATES.

In 1908, statistics of developed water power were compiled by the Census for the National Conservation Commission. The total water power reported at that time was 5,356,680 h. p., of which 3,396,103 h. p. represented developments of 1,000 h. p. or over, and the remaining 1,960,577 h. p. represented developments of less than 1,000 h. p. The Census figures included all power sites developed, and also undeveloped power sites upon which some expenditure had been made.

The statistics of developed water power collected by the Bureau of Corporations are, as a rule, applicable as of about June, 1911, and represent developments completed or under construction at that time. They include only developments of 1,000 h. p. and over, except in cases where a concern owning less than 1,000 developed h. p. owns enough undeveloped power to make a total of 1,000 h. p. or more.

The installed wheel capacity was made the basis of the Bureau's compilations. While this results in some exaggeration of the amount of power actually developed in practice, no other measurement is equally satisfactory.

Developed water power has been divided into two general classes: First, "commercial" power, which includes power developed for sale, and also that developed by municipalities and public-service corporations; and, second, "manufacturing" power, which includes power developed by manufacturing concerns and mainly used by themselves.

The total developed water power of the United States as thus computed by the Bureau, in June, 1911, excluding developments of less than 1,000 h. p. each, is 4,016,127 h. p. Of this, 2,961,549 h. p. is classed as "commercial" power, and 1,054,578 h. p. as "manufacturing" power. Adding 2,000,000 h. p. to represent the power of developments of less than 1,000 h. p. each (this being the total, in round numbers, as reported to the Census in 1908), gives a grand total, in round numbers, of at least 6,000,000 h. p. as the total water power of the United States developed and under construction in June, 1911.

There is a marked geographical concentration of developed water power (as well as the similar concentration of potential power set forth above). Thus, nearly 50 per cent of the developed "commercial" water power of the country is located in five States, as follows:

	Per cent.
California	14
New York	13
Washington	10
Pennsylvania	6
South Carolina	5
Total	48

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An even more marked concentration of developed water power employed in manufacturing is shown by the following summary:

	Per cent.
New York	30
New England States	36
Minnesota and Wisconsin	17
South Carolina	5
Total	88

SOME PROBLEMS OF WATER-POWER DEVELOPMENT.

VARIATIONS IN POWER DEMAND AND SUPPLY.—Certain physical and economic facts must be recognized in discussing water-power possibilities. The production and consumption of power are simultaneous. It is not possible practically to store overproduction for future demands when production may be light. The three principal demands for power are for lighting, traction, and manufacturing. If the greatest demand from each of these three sources came at a different period of the day, the total would be so distributed as greatly to reduce the required maximum capacity of the power plant. As a matter of fact, neither of these demands is uniform, while they more or less overlap. Thus, the demand for power for lighting tends to reach a maximum about the time that the demand for transportation is at its height. This overlapping creates what is known as the "peak of the load." It is imperative, therefore, to provide sufficient power to meet this maximum demand. Aside from these daily fluctuations in the power market, there is also a seasonal fluctuation. The demand in winter is greater than in summer. The daily fluctuation, moreover, is greater in winter.

In addition to this fluctuation in the demand there is also a variation in the supply of water power available. This is due to the fluctuating flow of streams. The flow varies according to the location and character of the drainage basin and according to seasons, and the seasons themselves, of course, vary in different years. A water-power installation, therefore, must also take these factors into account. If the installation provides only for utilizing the minimum flow there must be a tremendous waste of energy during the period of larger flow. On the other hand, as already stated, it is impracticable to install power up to the maximum potentially available.

REMEDY FOR VARIATIONS IN SUPPLY AND DEMAND FOR POWER.—The problem of a power producer is to meet these varying conditions of demand and supply in the most economical way. There are several means contributing to this end.

The physical effect of irregularity in the flow of streams can be partly overcome by storage. In no case, however, can storage give a stream anything like the power represented by its maximum flow.

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The amount of storage practicable depends upon the topography of the country and upon the value of the lands overflowed. Up to this time very little progress has been made in storage development.

Aside from storage, it is possible to accomplish something by "pondage," that is, the accumulation of water from day to day in power-dam ponds during that portion of the day when the demand is smallest.

A more effective remedy is in "coupling up," into one unit, two or more sites accessible to the same markets. In practically all cases some of the developments can cease operations when the highest demand is over and accumulate pondage to be brought into use at the period of highest demand the next day. In the meantime the other sites can meet the diminished demand.

The variableness of power supply and power demand, however, can not be entirely cured, even by storage, pondage, and "coupling." The effective remedy is the use of auxiliary steam plants. In nearly all cases hydraulic concerns must provide sufficient steam auxiliaries to meet variations not otherwise met.

ADVANTAGES OF UNIFICATION OF DEVELOPMENTS.—On the other hand, if a power site or a group of power sites provides more power than a single market can consume, all the power can be utilized by "coupling up" two or more markets.

The economic advantages gained by the "coupling up" of sites or markets, or both, by means of transmission lines, obviously are great. It is apparent that the most efficient use of water power from an economic point of view is facilitated by thus gathering into a single unit all the power available for a given market or a group of markets, using the same system of transmission lines. The independent operation of two sites may involve a great waste of energy and capital. In fact, in the case of a comparatively small water power at a long distance from a market it might be virtually impossible to develop it except in connection with some other site. In the same way, in the case of storage, there is an advantage in large-scale operations. This is because water gathered in storage reservoirs contributes to every power site below, thus making it advantageous to control all the sites dependent upon a storage project.

CONCENTRATION OF OWNERSHIP AND CONTROL.

From the above facts it is clearly seen that in many instances local concentration carries with it great economic advantages. Such concentration, however, demands rigid supervision, either Federal or State, to protect the public from the abuse of monopolistic power. When such local concentrations in several sections are themselves interconnected under a unified control another important and a different problem is presented.

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As this report clearly shows, there is a general and marked tendency toward concentration in the control of water power. Such concentration takes two forms. One is the single ownership of practically all the power in a given locality and the other is the ownership of water power in scattered localities by a single interest. The two are often found together.

Certain forces in the water-power industry tend peculiarly toward concentration. The unification of developments and of storage, and of markets as well, incident to the highest efficiency in the utilization of water power, as just described, clearly tend toward concentration of control. Concerns undertaking the development of water power tend to acquire all available power in a given community because of the advantages of unified operation above outlined.

Another circumstance leading toward concentration of control is the fact that the practical limit of electric transmission of water power is only about 200 miles. This, it will be seen, makes it virtually impossible for a water-power concern in one part of the country to compete with another water-power concern in a distant part of the country. Aside from this limitation on transmission of power, moreover, is the fact that, as a rule, the total demand for power within an area of practicable transmission is almost invariably greater than the supply of water power alone. The Bureau's investigation shows that in no considerable area is the supply of power now generated from water sufficient to meet the total power demand. Owing to the large investment required to develop a water power, and to this general limitation upon the supply, the most economical utilization of such power frequently results in concentrating all the power developed within a given area under a single control.

A peculiar circumstance which tends to accelerate concentration of water-power ownership is found in the commercial customs prevailing among manufacturers of machinery and supplies for the generation of electricity. Such manufacturers, in order to expand their business, often accept the securities of hydroelectric companies in payment, at least in part, for machinery and supplies. They have thus been led to enter actively into the hydroelectric field. Since the manufacture of such machinery and supplies is largely concentrated in a few hands, this obviously tends toward a corresponding concentration of water-power ownership.

Again, a number of financial houses making a specialty of financing water-power developments have become interested in water powers, and this has created another class of controlling interests. Furthermore, many officers and directors of equipment concerns and of engineering and financial houses have become individually interested in the same water-power developments, thus bringing about a close relationship between the two interests.

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Still again, as shown later, there is an increasing interrelationship between water-power enterprises and public-service interests.

The concentration of ownership of developed water power has steadily grown until in any given community it is usually all under a single control, or substantially so. Absolute ownership of all the power in a locality by a single interest, however, is not necessary to establish control. If one concern owns the most advantageous sites, and has a strong foothold in the markets, it has a dominating position in that area.

Such concentration of ownership has been most marked in the development of water power for commercial use. There are, however, a few instances of marked concentration of the ownership of water power used in manufacturing. The most noteworthy instance of this is found in the International Paper Co.

CONTROL OF WATER POWER IN SPECIFIC LOCALITIES.

There are numerous localities of greater or less extent in which practically all the developed water power is under a single control, or under the control of a very few interests. Some of the most important instances of this are here cited.

CONCENTRATION IN THE FAR WEST.

CALIFORNIA.—In California six corporations, nominally distinct, with their subsidiaries, control over 86 per cent of all the developed power in the State. The first three in the list below are more or less interrelated. These companies, with their holdings of developed power, are:

	Horsepower.
Pacific Gas & Electric Co	118,343
Western Power Co. (which owns the Great Western Power Co.)	60,000
Northern California Power Co. (Cons.)	46,900
Sierra & San Francisco Power Co	65,500
Southern California Edison Co	38,540
Pacific Light & Power Corporation	45,400
Total	374,683

There are two broad areas of concentration in California—one in the vicinity of San Francisco, and the other at Los Angeles. In the San Francisco region the Pacific Gas & Electric Co., with its subsidiaries, practically dominates the water-power situation. In addition to 118,343 h. p. owned by this company, it buys the equivalent of at least 26,600 h. p. from the Great Western Power Co., and 10,000 h. p. from the Northern California Power Co. (Cons.). It is true that there is a great deal of undeveloped water power in this region which the company does not own. However, because of its strong market position, this does not prevent it from having a fairly effective monopoly.

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The operations of this company and its subsidiaries cover the north-central portion of California, embracing 30 counties. More than 200 cities and smaller communities are served by the company, and more than two-thirds of the people of the State are in this area. The company owns electric-light distributing systems in more than 40 cities and towns. It also owns the street-railway lines of Sacramento and its suburbs, and has contracts with most of the street-railway and lighting companies in other towns reached by its lines, with the exception of the street railways in San Francisco. This strong control of markets probably constitutes the most important element of monopoly enjoyed by this company.

The Great Western Power Co. and the Northern California Power Co. (Cons.) operate in the territory served by the Pacific Gas & Electric Co., but, as just shown, they sell a considerable part of their power to that concern. The Sierra & San Francisco Power Co. is controlled by the United Railways Investment Co. of San Francisco, and practically all its power is used in the operation of the latter concern's street railroads, and therefore does not come in direct competition with that of the Pacific company.

In the southern part of the State two concerns—the Southern California Edison Co. and the Pacific Light & Power Corporation—control practically all the developed power. The city of Los Angeles is now constructing a power development that is intended to do the public lighting, and it will no doubt have some power for sale.

WASHINGTON.—The total developed water power in the State of Washington is 300,510 h. p. Of this 210,000 h. p., or about 70 per cent, is owned by two companies and their subsidiaries, as follows: Pacific Coast Power Co., 77,000 h. p., and Washington Water Power Co., 133,000 h. p.

In the Puget Sound region there is developed and under construction in all a little less than 135,000 h. p. The cities of Seattle and Tacoma own about 53,000 h. p., thus leaving in round numbers 82,000 h. p. in private hands. The Whatcom County Railway & Light Co., with 3,300 h. p., is under the same management as the Pacific Coast Power Co. mentioned above.

In the Spokane region, there are 145,000 h. p., developed and under construction, and this is all owned by two companies, the Washington Water Power Co., with 133,000 h. p., and the Spokane & Inland Empire Railroad, with 12,000 h. p. The Washington Water Power Co. also owns 18,000 h. p., developed, at Post Falls, Idaho, and it has 24,000 h. p., undeveloped, on the Spokane River in the State of Washington. The Spokane & Inland Empire Railroad is primarily a transportation company, and uses practically all its power in the operation of its trains. The Washington Water Power Co., therefore, abso-

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lutely dominates the general power field in this region. The company owns and operates street railways in Spokane, besides interurban lines, which together have 100 miles of track; it furnishes all the electric current for lighting and power in Spokane; it has more than 530 miles of long-distance transmission lines, and furnishes light and power in Cœur d'Alene and other mining districts in Idaho.

In the Columbia River region, there is 20,810 h. p., developed. Of this, the Great Northern Railway owns 8,000 h. p., subsidiaries of the American Power & Light Co. 8,080 h. p., and the Wenatchee Gas & Electric Co. 4,730 h. p. The American Power & Light Co., through its subsidiaries, operates street railways in Walla Walla, and an interurban railroad from Walla Walla, Wash., to Milton, Oreg. This company is connected with the Washington Water Power Co. through a contract under which the surplus power generated by one company can be taken by the other.

In brief, practically all the developed power in the western part of the State is under a single control; that in the eastern part is likewise nearly all controlled by one interest; the best of the power in the south-central section is also under one control. Furthermore, the controlling interests in all these sections are more or less closely affiliated.

MONTANA.—In Montana two companies, the Butte Electric & Power Co. and the United Missouri River Power Co., together control 134,260 h. p., or 96 per cent of the total developed water power of the State, as follows: Butte Electric & Power Co., 69,260 h. p., and United Missouri River Power Co., 65,000 h. p.

There does not appear to be any corporate relationship between these two companies. The transmission lines of the Butte and the United Missouri River companies extending from Butte are parallel, but they do not always enter the same cities. Thus the Butte Electric & Power Co. does not enter the city of Helena, apparently leaving that field to the United Missouri River Power Co. In Butte the Butte Electric & Power Co. does an electric-light and steam-heating business, while the Missouri River concern appears to have the general power business among the mines in that vicinity. There are 10 counties embraced either within the operations of these companies or within reach of them, and these counties, which include the cities of Butte, Helena, and Anaconda, contain about 45 per cent of the population of the State.

COLORADO.—In Colorado the Central Colorado Power Co. controls all the developed water power in the vicinity of Denver, and out of a total of less than 70,000 h. p., developed, in this State, Central Colorado Power interests control in all, directly and indirectly, 47,000 h. p. Its operations cover the central portion of the State, and no

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other power owner in this region can be considered its competitor. In addition to its developed power, it owns some 50,000 h. p. undeveloped, and its water powers are on the whole the most available ones in the territory where it operates. It has a strong market position. Its transmission lines extend to Denver, Georgetown, Idaho Springs, Central City, and vicinity. It has a contract to sell power to the Northern Colorado Power Co., a large steam-generating concern, thus indicating its freedom from any serious competition from that source.

The same interests that own the Central Colorado Power Co. dominate the San Juan Water & Power Co., which practically controls the power situation in the vicinity of Durango, in the southwestern part of the State.

CONCENTRATION IN THE SOUTH.

SOUTH CAROLINA.—The Southern Power Co. owns approximately 101,000 h. p., or about 75 per cent of all the commercially developed water power in this State and 73,000 h. p. of the most available undeveloped. On the Broad and Catawba Rivers, the principal power streams in South Carolina, the company owns more than 82 per cent of the commercially developed power and practically all of that undeveloped. It also owns 31,000 h. p., undeveloped, in North Carolina.

The developments of the Southern Power Co. are all within about 50 miles of Spartanburg, S. C. Its transmission lines, however, cover the principal cotton-manufacturing districts of South Carolina, and extend in North Carolina to Charlotte, Salisbury, Winston Salem, Greensboro, and as far east as Durham. The extreme distance from Durham, N. C., to the farthest points served in South Carolina is about 265 miles. This territory includes between 150 and 200 cotton mills, with more than 5,000,000 spindles and 120,000 looms. The mills now supplied with power by this company operate more than 2,000,000 spindles and 42,500 looms. The Southern Power Co. occupies a dominating position in this territory.

NORTH CAROLINA.—The largest power developments in North Carolina are at Whitney and Rockingham, on the Yadkin River, each of which will have a capacity of 32,000 h. p. Power is not yet being generated at these points, but construction work is rapidly approaching completion. The Rockingham plant is controlled by the Carolina Power & Light Co., which also owns 5,000 h. p., developed, on the Neuse and Cape Fear Rivers, and which controls the power markets of Raleigh and other less important communities. The plant at Whitney is owned by the North Carolina Power & Electric Co.

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GEORGIA.—The total commercial power developed and under construction in this State is 126,927 h. p. Five companies control 109,050 h. p., as follows:

	Horsepower.
Atlanta Water & Electric Power Co.	16,800
Georgia Power Co.	53,250
Albany Power & Manufacturing Co.	3,500
Central Georgia Power Co.	24,000
Columbus Power Co.	11,500
Total	109,050

The Atlanta Water & Electric Power Co. and the Georgia Power Co., both operating in the vicinity of Atlanta, are completely dominated by a single group of capitalists, who, moreover, are largely interested in the Albany Power & Manufacturing Co., thus placing about 58 per cent of the commercially developed water power in the State in the hands of a single group.

The Central Georgia Power Co., operating in the vicinity of Macon, owns, in addition to its developed water power of 24,000 h. p., undeveloped sites with 120,000 estimated horsepower.

The development of the Columbus Power Co. includes all the developed power at Columbus except 6,400 h. p. owned by a cotton manufacturing concern, and the company also has undeveloped power estimated at 63,500 h. p.

CONCENTRATION IN THE LAKE REGION.

LOWER PENINSULA OF MICHIGAN.—Water-power ownership in this region is highly centralized, fully 73 per cent of all the commercial power being controlled by the Commonwealth Power, Railway & Light Co. This company and its subsidiaries own 51,800 h. p., developed, and 41,000 h. p., undeveloped. The same interests are reported to control an additional 30,000 h. p., undeveloped. This company controls street-railway and lighting companies that use a large portion of the power produced, and it has in a number of towns gas companies that otherwise might be competitors of its electric-lighting concerns. It dominates the power situation in such important cities as Grand Rapids, Saginaw, Bay City, and Kalamazoo, besides a large number of less important communities. It has practically no water-power competitor in the State.

WISCONSIN.—The concentration of water power here has not progressed as far as in some States, but there is a marked movement in that direction. More than half of the developed power is owned by manufacturing concerns, principally in the lumber and pulp and paper industries. As the raw material for these industries diminishes the power will naturally be diverted to commercial use.

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CONCENTRATION AT NIAGARA FALLS.

At Niagara Falls there is developed, on both sides of the river, in round numbers, 500,000 h. p. Of this, 262,000 h. p. is on the American side. All of this is owned by two companies—namely, the Hydraulic Power Co. of Niagara Falls and the Niagara Falls Power Co. The latter company, moreover, owns all the stock of the Canadian Niagara Power Co., with 62,500 h. p., developed, on the Canadian side. On the Canadian side three other companies have 175,000 h. p., developed, of which the Ontario Power Co. of Niagara Falls owns 120,000 h. p.

All of the power generated on the American side, and approximately 120,000 h. p. of that generated on the Canadian side, is consumed in the United States.

SUMMARY OF LOCAL CONTROL.

In California the bulk of the power produced in the northern half of the State is controlled by a single interest, and that in the southern half by only two companies. In Montana two companies control 96 per cent of all the developed power of the State; and in Washington a single interest controls the power situation in the Puget Sound region, while another interest, more or less closely affiliated with it, controls the developed power elsewhere in the State. All the developed power in the vicinity of Denver, Colo., and nearly 70 per cent of the total developed power in that State, is controlled by one interest. In South Carolina one corporation owns 75 per cent of the developed commercial power, while in North Carolina 45 per cent of such power, developed and under construction, is controlled by a single interest. One group of interests practically controls 58 per cent of all the commercial power, developed and under construction, in Georgia. In the Lower Peninsula of Michigan a single group owns 73 per cent of all such power. The great development at Niagara Falls on the American side is controlled by only two companies.

CONCENTRATION OF OWNERSHIP AND CONTROL BY INTERESTS.

The local concentration of water power, just described, by no means reveals the full extent of concentration of ownership. A few large interests have acquired such control over water power as to bring about a still greater concentration. These interests not only control the power situation in entire communities, but they also control vast amounts of power in widely separated localities, and have thus become exceedingly important factors in the water-power situation as a whole. This broader field of control has also included all sorts of public-service corporations regardless of whether these involve water power or not.

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The actual control of water-power developments and public-service corporations by the same interests is but little more significant than the fact that these interests are gradually widening their influence through representation on directorates, even where a corporation itself owns no stock.

Some idea of the extent of such concentration of control is found in the fact that of the total "commercial" water power of 2,961,549 h. p., developed and under construction, in the United States above given (p. 5), over 1,800,000 h. p. is controlled to a greater or less extent—but not absolutely in every case—by 10 groups of interests. These groups, together with the amount of water power influenced by each, are as follows:

COMMERCIAL WATER POWER CONTROLLED BY OR UNDER THE INFLUENCE OF COMPANIES OR GROUPS OF INTERESTS EACH HAVING 50,000 H. P. OR MORE ACTUALLY DEVELOPED OR UNDER CONSTRUCTION.

[The degree of control varies greatly, as set forth in the text.]

Companies or groups of interests.	Developed and under construction.	Undeveloped.	Total.
General Electric interests:	h. p.	h. p.	h. p.
A. Power completely controlled	82,860	5,500	88,360
B. Power coming under General Electric influence where there occurs both minority ownership of securities and common directors	419,060	522,600	941,660
C. Power coming under the sphere of General Electric influence through common directorships only	437,195	113,500	550,695
Total, General Electric group	[1] 939,115	[2] 641,600	1,580,715
Stone & Webster interests	278,067	372,350	650,417
Hydraulic Power Co. of Niagara Falls	144,000	20,000	164,000
Pacific Gas & Electric Co	118,343	100,000	218,343
Clark-Foote-Hodenpyl-Walbridge interests	104,300	158,000	262,300
Southern Power Co	101,680	104,000	205,680
S. Morgan Smith interests	76,550	96,000	172,550
Brady interests	70,600	16,200	86,800
United Missouri River Power Co	65,000	.....	65,000
Telluride Power Co	[3] 56,350	21,300	[3] 77,650
Grand total	[4] 1,821,305	[4] 1,449,450	[4] 3,270,755

[1] Includes 84,700 h. p. also included with Stone & Webster interests and 48,000 h. p. included with Clark-Foote-Hodenpyl-Walbridge interests.

[2] Includes 5,000 h. p. also included with Stone & Webster interests and 75,000 h. p. included with Clark-Foote-Hodenpyl-Walbridge interests.

[3] Including 4,500 h. p. belonging to the Beaver River Power Co.

[4] Does not include power duplicated in General Electric, Stone & Webster, and Clark-Foote-Hodenpyl-Walbridge interests.

In addition to the large holders shown in this table, there are 7 companies each having between 25,000 and 50,000 h. p., and, of these, 4 have more than 40,000 h. p. each. Thus 17 interests or

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groups of interests control or strongly influence more than 2,000,000 h. p. of commercial water power, developed and under construction, or more than 70 per cent of all such power in the United States. These figures, it should be noted, do not include such large industrial concerns as the International Paper Co., which controls more than 190,000 developed horsepower, and the Aluminum Co. of America, which has 48,000 h. p., developed and under construction.

Of the 10 groups of interests enumerated in the preceding table, it will be seen that the General Electric interests have more than 50 per cent of the developed power and nearly 50 per cent of the total power, developed and undeveloped, there included. The General Electric and Stone & Webster groups together have more than 60 per cent of the developed power included in the table and nearly 40 per cent of all the developed commercial power in the United States.

It should be clearly understood that the Bureau does not contend that these various groups completely control the power here credited to them. It is not possible in every instance definitely to determine the degree of control that is exercised. The evidence of influence in some cases is found in the corporate ownership of securities of water-power concerns as well as representation on their boards of directors, while in other cases the evidence is simply that of common directors alone. The ownership of the majority of the stock in a corporation is not a necessary prerequisite to its control. Directors of a company who own but a small fraction of the stock may control it by virtue of business connections, through which they exercise a powerful influence. It is safe to assume that the officers and directors of large equipment, engineering, and financial concerns do not enter the directorates of water-power companies as mere figureheads.

GENERAL ELECTRIC INTERESTS.

The General Electric Co. is the largest manufacturer of electrical machinery and apparatus in the world. From its close associations with hydroelectric concerns it has, through its principal subsidiaries and a number of its most prominent officers and directors, become largely interested in water-power projects. In this way a vast amount of water power has become subject to General Electric influence. Indeed, the greatest number of water-power companies and the largest amount of water power comprised within the sphere of control of any single interest is that falling under the influence of the General Electric Co.

The General Electric Co. itself directly controls very little water power. Its control is chiefly exercised through its three subsidiary

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concerns, namely, the United Electric Securities Co., the Electrical Securities Corporation, the Electric Bond & Share Co.

The common stock of all three of these companies is owned by the General Electric Co. The General Electric Co. and these subsidiaries will, for convenience, be designated as the "General Electric companies." The water-power companies which have been brought under this influence may be arranged in three groups, according to the degree of control. These groups are designated "A," "B," and "C."

Group "A" includes those water powers which are completely controlled by the "General Electric companies." In most cases this control is evidenced by the holding of a majority of the stocks. Group "B" includes those companies of whose securities a portion, usually small, is held by the "General Electric companies," and some of whose officers and directors are officers or directors of the "General Electric companies." Group "C" includes those companies some of whose officers and directors are also officers and directors in the "General Electric companies," or which are in some way connected with interests allied with the General Electric Co., but without corporate ownership of securities.

GROUP A.—This group includes 6 companies, as follows:

Companies.	Locality.	Power developed and under construction.
		h. p.
American Power & Light Co	Oregon and Washington	15,840
Asheville Electric Co	North Carolina	260
Carolina Power & Light Co	do	37,000
Consolidated Power & Light Co	South Dakota	2,000
Rockford Electric Co	Illinois	1,760
Schenectady Power Co	New York	26,000
Total		82,860

Besides the 82,860 developed horsepower shown in the table, these companies own 5,500 h. p., undeveloped.

Of the above concerns the Schenectady Power Co. is owned outright by the General Electric Co. and practically all of its power is used at the General Electric works at Schenectady. The Carolina Power & Light Co., as already shown, owns water power on the Cape Fear River in North Carolina. It controls through lease a developed power site on the Neuse River; it also controls by stock ownership the Yadkin River Power Co., on the Yadkin River.

The American Power & Light Co. has already been referred to. The other concerns in this group are small.

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GROUP B.—This group includes 8 principal corporations and two subsidiaries, with nearly 420,000 h. p. water power, developed and under construction, and over 520,000 h. p., undeveloped, as follows:

Companies.	Locality.	Water power.	
		Developed and under construction.	Undeveloped.
		h. p.	h. p.
Butte Electric & Power Co	Montana	69,260	97,600
Central Colorado Power Co	Colorado	39,000	50,000
Northwestern Power Co	Minnesota	39,000	20,000
Pennsylvania Water & Power Co	Pennsylvania	135,000	.....
Sierra & San Francisco Power Co	California	65,500	50,000
San Juan Water & Power Co	Colorado	8,000	.....
Western Power Co	California	60,000	300,000
Whatcom County Railway & Light Co	Washington	3,300	5,000
Total		419,060	522,600

It is impossible to determine accurately the degree of influence that the General Electric companies exercise over these corporations. The percentage of securities actually owned is in most cases comparatively small, that of stock alone seldom amounting to as much as 5 per cent of the total. On the other hand, the personal representation of General Electric interests on boards of directors would indicate that some of these companies are possibly completely dominated by General Electric influence.

Some of these companies are among the largest water-power concerns in the country, and, moreover, practically dominate the power situation in the States in which they operate. Thus the Butte Electric & Power Co., as already shown, occupies a commanding position in the water-power industry in Montana, while the Central Colorado Power Co., together with the San Juan Water & Power Co., with which it is affiliated, have an almost complete control of developed water power in Colorado. The power of the Northwestern Power Co., in Minnesota, is owned by the Great Northern Power Co., a subsidiary. The Great Northern Power Co. owns all the common stock of the Northern Power Co., of Wisconsin, through which it distributes electricity in that State. It owns in fee rights of way for transmission lines in the city of Duluth, as well as a franchise for 6 miles of underground conduit in that city. In the city of Superior it supplies power to the Superior Water, Light & Power Co.

The Sierra & San Francisco Power Co. is controlled by the United Railways Investment Co. of San Francisco, and nearly all of the power generated by it is employed by street railways in that city.

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The Western Power Co., the water power of which is owned by a subsidiary, the Great Western Power Co., as already shown, sells a large portion of its power to the Pacific Gas & Electric Co.

The Whatcom County Railway & Light Co. does the street-railway, electric-light, and gas business of Bellingham, Wash. It owns the entire capital stock of the Bellingham-Skagit Railway Co.

The power of the Pennsylvania Water & Power Co. is all at McCall Ferry, on the Susquehanna River. The company sells 20,000 electrical h. p. to the Consolidated Gas, Electric Light & Power Co. of Baltimore, which concern controls the entire light and power business of that city.

GROUP C.—There are 10 companies in this group, with over 437,000 developed horsepower and 113,500 h. p., undeveloped. The developed power is shown below:

Companies.	Locality.	Developed water power.
		h. p.
Albany Southern R. R.	New York	6,320
Colorado Springs Light, Heat and Power Co	Colorado	3,000
Manchester Traction, Light & Power Co	New Hampshire	10,000
Niagara Falls Power Co	Niagara Falls	[1] 118,300
North American Co	Various	[2] 69,780
Portland Railway, Light & Power Co	Oregon	48,000
Puget Sound Power Co	Washington	20,000
Tampa Electric Co	Florida	1,400
Turners Falls Co	Massachusetts	9,425
Washington Water Power Co	Washington and Idaho	151,000
Total		437,195

[1] Not including 62,500 h. p. on the Canadian side owned by an affiliated concern.
[2] Of which 68,000 electrical h. p. (i. e., in form of electricity) is purchased from other companies.

The connection of the companies included in this group with "General Electric companies" is through common officers or directors. The mere presence of such representatives of the General Electric companies in power concerns does not necessarily imply a high degree of control. In most cases, however, such common directors are men who are more or less prominent in General Electric affairs, and in some cases, at least, a considerable degree of influence is indicated. It should be clearly understood, however, that these companies are presented as coming within the sphere of influence, and not necessarily under the effective control, of the "General Electric companies."

The most important company in this group is the Niagara Falls Power Co. In all it has over 180,000 developed horsepower, this including 62,500 h. p. on the Canadian side of the Falls owned by the

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Canadian Niagara Power Co. (which also owns 62,500 undeveloped horsepower on that side of the river), all the stock of which is owned by the Niagara Falls Power Co. The Niagara Falls Power Co. also owns a majority of the stock of the Cataract Power & Conduit Co. and all the stock of the Tonawanda Power Co., which distribute power in Buffalo and Tonawanda, respectively. The former concern furnishes most of the power of the International Railway Co., which operates the street railway systems of Buffalo and vicinity, with approximately 375 miles of track.

A direct connection between the General Electric Co. and the Niagara Falls Power Co. is established through the firm of J. P. Morgan & Co., which has a very strong representation on the directorates of both concerns.

The Washington Water Power Co., which operates in the vicinity of Spokane, Wash., as shown, practically dominates the water-power situation in that region. Hinsdill Parsons, vice president of the General Electric Co. and a director of the Electric Bond & Share Co. (a subsidiary of the General Electric) is a director of this concern.

The North American Co. is not primarily a water-power corporation, but is a holding company. It controls, through stock ownership, the street railways of Milwaukee and vicinity, St. Louis and vicinity, and a number of electric-light and gas companies in smaller towns. Most of the power credited to it in the above summary is controlled through contracts with other companies. Thus, through a subsidiary, it has a contract with the Mississippi River Power Co. for 60,000 electrical horsepower delivered in St. Louis. It also purchases 8,000 h. p. from the Southern Wisconsin Power Co. Through a subsidiary, it does the entire commercial electric-lighting business of Detroit. The North American Co. is closely affiliated with General Electric interests. C. A. Coffin, president of the General Electric Co., George R. Sheldon, president of the Electrical Securities Corporation, and C. W. Wetmore, a director of the Electric Bond & Share Co., are all directors in the North American Co.

The Portland Railway, Light & Power Co., with 48,000 h. p., developed and under construction, and 75,000 h. p., undeveloped, owns and controls practically the entire street-railway and electric-lighting business of Portland and Salem, Oreg., electric light and power plants in Oregon City, Woodburn, and several other Oregon towns, and also in Vancouver, Wash. Two directors of the Electric Bond & Share Co. (a subsidiary of the General Electric Co.) are directors in the Portland Railway, Light & Power Co.

The Puget Sound Power Co. is a subsidiary of the Seattle Electric Co., which in turn is controlled by the Pacific Coast Power Co. Its power is distributed in Tacoma, Seattle, and intermediate points for

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railway, lighting, and other purposes. S. Z. Mitchell, president and a director of the Electric Bond & Share Co., is a director of the Puget Sound Power Co.

The Colorado Springs Light, Heat & Power Co. is a subsidiary of the Susquehanna Railway, Light & Power Co., through which it is related to the General Electric interests. It controls the entire electric light and power business in Colorado Springs and Colorado City, Colo.

The smaller concerns in this group, namely, the Albany Southern Railroad, the Manchester Traction, Light & Power Co., the Tampa Electric Co., and the Turners Falls Co., each have on their directorates one individual who is a director in one or more of the "General Electric companies."

It should be noted that some of the power in Groups B and C, namely, that of the Whatcom County Railway & Light Co., the Puget Sound Power Co., the Tampa Electric Co., and a portion of that of the Mississippi River Power Co., is here grouped under the General Electric influence, although these companies are actually operated by another group of water-power interests, the Stone & Webster Management Association, discussed later.

SUMMARY FOR GENERAL ELECTRIC GROUP.—The General Electric companies have a very extensive influence in the water-power business of the United States. As shown in the table on page 15, the total water power, developed and under construction, of the companies involved in these interests is almost 940,000 h. p. Adding to this 62,500 h. p. developed by the Canadian Niagara Power Co., on the Canadian side of Niagara Falls, and sold in the United States, makes a grand total of over 1,000,000 h. p., developed and under construction, coming under the influence of the General Electric Co. The companies included in the General Electric group own water power in 18 States. These States have 2,325,757 "commercial" horsepower, developed and under construction. Of this, 40 per cent is in the General Electric group described. In Pennsylvania they control nearly 80 per cent, in Colorado 72 per cent, in New Hampshire 61 per cent, in Oregon 58 per cent, and in Washington 55 per cent.

In addition to their developed power, these companies own 641,600 h. p., undeveloped. There is, therefore, total water power in the United States of at least 1,580,000 h. p. coming under the General Electric group. These figures assume a much higher significance when it is understood that they generally represent not only the best, but in some instances all, the water power practically available in the respective communities. It should be repeated, however, that the "General Electric companies" do not have complete control of all these concerns, but that in the case of many they simply have a voice in their management through representation on directorates.

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STONE & WEBSTER GROUP.

The Stone & Webster organization consists primarily of the partnership of Stone & Webster. This partnership owns the stock of the Stone & Webster Engineering Corporation and the Stone & Webster Management Association; it also controls the Public Service Investment Co. The Stone & Webster Management Association manages and operates municipal public-service corporations of practically every character and in every section of the country. The Stone & Webster interests do not necessarily own a majority of the securities of the companies they operate (in some cases they hold no securities therein), but the fact of their management makes them an important, if not the dominant, factor in the control of these corporations. The real significance, therefore, of the relations of Stone & Webster to the corporations under their management lies primarily in the fact that they are operated by the Stone & Webster Management Association and not in the ownership of securities.

There are 36 corporations under this management in the United States. There are more than 20 other corporations subsidiary to those managed, thus placing directly or indirectly under this management between 55 and 60 companies.

Eight of the companies under this management own water power as follows:

Companies.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Mississippi River Power Co.	[1] 150,000	150,000
Pacific Coast Power Co.	[2] 77,000	53,000
Minneapolis General Electric Co.	18,750	76,250
Sierra-Pacific Electric Co.	14,200	24,000
Columbus (Ga.) Power Co.	11,500	63,500
Whatcom County Railway & Light Co.[3]	3,300	5,000
Blackstone Valley Gas & Electric Co.	1,917	600
Tampa Electric Co.[3]	1,400	.....
Total.	278,067	372,350

[1] A portion of this (60,000 h. p.) is also included in the General Electric group (p. 20).
[2] A portion of this (20,000 h. p.) is also included in the General Electric group under Puget Sound Power Co. (p. 19).
[3] Also included in the General Electric group (pp. 18, 19).

By far the largest development in this group is that of the Mississippi River Power Co., on the Mississippi River at Keokuk, Iowa, with 150,000 h. p. under construction. This company has a contract with the Mississippi River Power Distributing Co., a subsidiary of the North American Co., to deliver 60,000 electric horsepower in the city of St. Louis.

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In the Puget Sound region, in Washington, through the Pacific Coast Power Co. and the Whatcom County Railway & Light Co. the Stone & Webster interests manage 80,300 h. p., developed and under construction, or nearly 60 per cent of all such water power in that region. In addition they have 58,000 h. p., undeveloped. The significance of the control of this power has already been discussed.

The Sierra-Pacific Electric Co. operates in Nevada, and dominates the water power in a large portion of that State. Its transmission lines extend to Reno, Virginia City, Carson City, and also into the extensive mining districts to the eastward of those points.

The Minneapolis General Electric Co. operates in Minneapolis, Minn., and vicinity.

The Columbus Power Co., a subsidiary of the Columbus Electric Co., as already shown, controls all the commercial water power at Columbus, Ga.

CLARK-FOOTE-HODENPYL-WALBRIDGE INTERESTS.

This is a group of banking interests whose influence extends over 104,000 h. p., developed, and 158,000 h. p., undeveloped. The principal water-power concerns coming under the control or influence of this group are the Commonwealth Power, Railway & Light Co., which has over 50,000 h. p., developed, and over 70,000 h. p., undeveloped, in Michigan; the Bangor Railway & Electric Co. and the Lewiston, Augusta & Waterville Street Railway, in Maine; the Union Railway, Gas & Electric Co., operating in Indiana and Illinois; the St. Joseph Railway, Light, Heat & Power Co., in Missouri; the Denver & Northwestern Railway, in Colorado; the Portland Railway, Light & Power Co., of Oregon (already referred to under the General Electric group).

PACIFIC GAS & ELECTRIC CO.

The Pacific Gas & Electric Co., with over 118,000 developed horsepower, and 100,000 h. p. additional, undeveloped, has already been referred to in discussing local concentration (p. 9). As there shown, this company is the dominating factor in the power situation in a large portion of California.

SOUTHERN POWER CO.

This company, as already shown, owns the great bulk of the commercially developed water power in South Carolina, and is the controlling power interest in the cotton-manufacturing section of that State, and is also an important power factor in North Carolina.

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S. MORGAN SMITH INTERESTS.

The companies falling in this group are associated with S. Morgan Smith Co. interests, of York, Pa., manufacturers of water wheels and power-transmission machinery. This company has no corporate connection with any water-power company except the ownership of a small block of the securities of the Savannah River Power Co. Its active head, C. Elmer Smith, however, is personally largely interested in water powers; he is the dominating factor in two large power developments in Georgia and he is interested in other smaller developments. The companies dominated by the Smith interests are:

Companies.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Georgia Power Co.	53,250	80,000
Atlanta Water & Electric Power Co.	16,800	.....
Total.	70,050	80,000

The companies in which there is considerable Smith interest, but possibly not absolute control, are:

Companies.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
The Albany Power & Manufacturing Co.	3,500	16,000
Savannah River Power Co.	3,000	.....
Total.	6,500	16,000

The dominant position of the Georgia Power Co. and the Atlanta Water & Electric Power Co. has been discussed elsewhere. (See p. 13.)

HYDRAULIC POWER CO. OF NIAGARA FALLS.

This company, which obtains its power from the Niagara River, has 140,000 h. p., developed and under construction, this not including 4,000 h. p. sold in the form of water, thus making the total power in its control 144,000 h. p. Of this total, 20,000 h. p. is held in reserve. The average daily output, including the 4,000 h. p. sold as water, is 88,000 h. p. Most of the current generated is sold for manufacturing purposes in the immediate vicinity of the power site.

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BRADY INTERESTS.

The companies classed under this head are those controlled by Anthony N. Brady, or with which he is closely identified. He controls the Chattanooga & Tennessee River Power Co., which is completing a plant on the Tennessee River, 18 miles below Chattanooga. This plant when completed will have a wheel capacity of 58,800 h. p.

Mr. Brady is also a prominent figure in—if he does not control—the Utica Gas & Electric Co., with water power amounting to 11,800 h. p., developed, and 16,200 h. p., undeveloped. It supplies electric light and power to Whitehall, and gas and electric light to Glens Falls, Sandy Hill, and Fort Edward, N. Y., and sells gas, electric light, and power in Utica and vicinity.

As shown later, the control of these corporations by A. N. Brady brings them into relation with a number of important public-service and industrial concerns.

TELLURIDE POWER CO.

This company owns 51,850 h. p. developed water power, mainly in Idaho, and 21,300 h. p., undeveloped. L. L. Nunn, general manager of the Telluride Power Co., is also president of the Beaver River Power Co., with a development of 4,500 h. p. at Beaver, Utah, making a total of 56,350 developed horsepower under this control, or a total, developed and undeveloped, of 77,650 h. p. The Telluride company has a transmission line from Grace, Idaho, to Salt Lake City, a distance of 135 miles. It furnishes power to a number of mining companies in southwestern Colorado, Utah, and parts of Idaho, and supplies a considerable part of the power used by the Utah Light & Railway Co., which controls the electric lighting of Salt Lake City and Ogden and operates the street railways of Salt Lake City. It also does the electric-light business of various towns in Colorado and Utah.

THE UNITED MISSOURI RIVER POWER CO.

This company has already been referred to in the description of concentration by localities (p. 11). It was there shown that the company has 65,000 h. p., developed or under construction, in Montana. This concern and the Butte Electric & Power Co. dominate the power situation in Montana.

H. M. BYLLESBY & CO.

This is an engineering and managing concern similar in character to Stone & Webster. It controls the Northern States Power Co., Northern Idaho & Montana Power Co., Western States Gas & Electric Co., and the Standard Gas & Electric Co., each of which is a consolidation or a merger of a number of other corporations; it also controls the

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Sioux Falls Light & Power Co., of South Dakota. The companies included under the Byllesby interests own developed water power to the amount of 19,965 h. p., and 22,100 h. p., undeveloped. In addition, one of the companies purchases 8,000 h. p. from the Washington Water Power Co., which is distributed at Sandpoint, Idaho, and vicinity, and another company purchases 1,000 h. p. from the Pacific Gas & Electric Co., which is distributed at Richmond, Cal. The companies in this group serve about 50 cities and towns in California, Washington, Oregon, Montana, Idaho, Wisconsin, Minnesota, North Dakota, South Dakota, and Illinois, and also furnish power to the lead and zinc mines in southwestern Wisconsin.

GOULD INTERESTS.

The companies falling in this group are dominated by Frank J. Gould and Edwin Gould. They control 21,600 h. p. of developed water power, and 28,500 h. p., undeveloped, all in Virginia. Of the developed power, 14,100 h. p. is at Richmond, 3,000 h. p. at Petersburg, and 4,500 h. p. at Fredericksburg. Nearly all the undeveloped power is at Fredericksburg. They operate 83 miles of electric railways in the city of Richmond and suburbs, 23 miles between Richmond and Petersburg, 14 miles in Petersburg and suburbs, 140 miles in Norfolk, Portsmouth, and vicinity, and electric light and power plants in Richmond and Petersburg. These interests operate altogether 260 miles of electric railways.

WESTINGHOUSE INTERESTS.

The group of business concerns commonly distinguished by the name "Westinghouse" embraces about 20 corporations engaged in the manufacture or sale of electrical machinery, a wide variety of electrical appliances, and brake and coupling devices for steam railroad cars. The most prominent is the Westinghouse Electric & Manufacturing Co., which manufactures and sells electrical machinery and appliances.

It is probable that the Westinghouse interests do not control absolutely any water-power development. They have such relation, however, to certain water-power concerns as to bring them within the scope of this discussion. George C. Smith, an active figure in water-power development, is a director in two or three of the Westinghouse companies; A. N. Brady, who is a director in the Westinghouse Electric & Manufacturing Co., controls large water powers, as just shown. The companies that thus have some sort of relation to the Westinghouse interests are: Atlanta Water & Electric Power Co., Chattanooga & Tennessee River Power Co., Utica Gas & Electric Co., Ontario Power Co. of Niagara Falls (Canadian).

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The relation of the Westinghouse interests to the Ontario Power Co. of Niagara Falls is through the Niagara, Lockport & Ontario Power Co. This latter company is a distributing concern that purchases power from the Ontario Power Co. of Niagara Falls. Fifty-five per cent of its stock is owned or controlled by the Westinghouse Electric & Manufacturing Co., and the remainder is owned by the Ontario Power Co. of Niagara Falls. While this connection is not direct, it is of such a character as to indicate a substantial relationship. The distributing company has transmission lines extending from Niagara Falls as far east as Syracuse, N. Y., and as far south as Lackawanna, N. Y.

The Westinghouse Electric & Manufacturing Co. owns $400,000 of a total of $1,500,000 of the capital stock of the Atlanta Water & Electric Power Co.; and George C. Smith, a prominent Westinghouse man, is a director in this company. As heretofore stated, however, it is controlled by the S. Morgan Smith interests.

The Westinghouse connection with the Chattanooga & Tennessee River Power Co. and the Utica Gas & Electric Co. arises from the fact that A. N. Brady, who, as just shown, has an important interest in these concerns, is a Westinghouse director.

INTERNATIONAL PAPER CO.

The largest amount of water power controlled by any industrial concern in the United States is that of the International Paper Co., amounting to 190,375 h. p., developed. Of this total, 158,304 h. p. is owned outright and 32,071 h. p. is leased from others. The power owned by this company is situated in Maine, New Hampshire, Vermont, and New York, with 40,376 h. p., 25,845 h. p., 19,750 h. p., and 72,333 h. p., respectively. Excluding developments of less than 1,000 h. p. each, this company owns more than 21 per cent of all the developed power, both commercial and manufacturing, in New Hampshire, and it owns or controls through leases more than 31 per cent of all such power in Vermont.

While the power of the International Paper Co. at the present time is almost exclusively used for manufacturing, in the future, as the forests tributary to the plants of the company become exhausted, an increasing amount of this power will be available for commercial purposes.

SUMMARY OF OWNERSHIP AND CONTROL BY INTERESTS.

The General Electric interests control the water-power situation in large portions of Washington, Oregon, Colorado, Montana, and elsewhere. The Stone & Webster interests exercise control (based largely, however, on management rather than ownership) in localities

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in Washington, Iowa, and Georgia. The Pacific Gas & Electric Co. practically dominates the power situation in a large number of localities in the northern half of California. The Southern Power Co. controls the power situation in South Carolina and has a strong foothold in North Carolina. The S. Morgan Smith interests dominate the power situation in the vicinity of Atlanta, Ga. The Telluride Power Co. controls absolutely a large territory in Utah and Idaho. The Commonwealth Power, Railway & Light Co., which is a part of the Clark-Foote-Hodenpyl-Walbridge interests, dominates the power situation in the Lower Peninsula of Michigan. The Gould interests control the best of the available water-power sites in the vicinity of Richmond, Va.

RELATIONS OF WATER-POWER COMPANIES TO PUBLIC-SERVICE CORPORATIONS.

The preceding discussion has indicated a rather general relationship between water-power companies and public-service corporations. This common control of the agencies of traffic and distribution of light in our cities, on the one hand, and the sources of power for operating them, on the other, is an exceedingly important feature of water-power development. The list of public-service agencies controlled by or affiliated with water-power concerns is rapidly increasing. Generally the relationship between water-power companies and public-service corporations is that of ownership, but there are cases in which there is merely affiliation through common officers or directors or the sale of power.

Some idea of the extent of such common control of public-service corporations by water-power companies is afforded by the fact that 6 water-power interests control street railways in 29 cities and towns, electric-lighting plants in 204, and gas plants in 55. A few conspicuous individual instances of such control are here mentioned.

The Pacific Gas & Electric Co., operating in northern central California, as shown, controls the street railways in 1 city, electric-lighting plants in 40, and a number of gas plants.

The Pacific Light & Power Corporation, in southern California, controls street railways in 2 cities, electric-lighting plants in 29, and gas plants in 2.

The companies included in the General Electric group control the street railways in 16 municipalities, electric-lighting plants in 78, and gas plants in 19. For example, these companies control, or are closely affiliated with, the street railways of Portland and Salem, Oreg., Spokane, Wash., Great Falls, Mont., St. Louis, Mo., Winona, Minn., Milwaukee and Racine, Wis., Elmira, N. Y., Asheville and Raleigh, N. C., not to mention numerous other less important points. They control the lighting plants (electric or gas) in most of the cities

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just mentioned, as well as in Leadville and Colorado Springs, Colo., and Detroit, Mich., and, in fact, have some lighting interest in one or more towns in practically every large area where they control water power. In addition to the public-service corporations thus controlled, there are numerous others that purchase power from the water-power interests controlled or affiliated with the General Electric Co. This is true in Denver, Colo., Baltimore, Md., Buffalo, N. Y., and other cities. Furthermore, the General Electric Co. has interests in public-service corporations in communities which do not have water-power service. Some of the largest public-service corporations in the country are subject to General Electric control or influence. Among these is the American Gas & Electric Co. This company, which is controlled by stock ownership (through the Electric Bond & Share Co.), comprises 13 lighting corporations operating in 7 different States. The Electric Bond & Share Co. controls the Omaha Electric Light & Power Co., and there is a strong General Electric influence in the Buffalo & Lake Erie Traction Co.

The Stone & Webster Management Association, as already shown, operates 36 different corporations, with more than 20 subsidiary concerns. The water-power companies under this management control the street railways in 5 cities and towns, electric-lighting plants in more than 25, and gas plants in at least 8.

In brief, in the country as a whole, water-power companies, or companies affiliated with them, own or control and operate street railways in no less than 111 cities and towns in the United States, electric-lighting plants in 669 cities and towns, and gas plants in 113 cities and towns. These companies, moreover, supply power to municipal lighting plants in a considerable number of cities and towns. Many of these are among the most important municipalities in the States involved. Furthermore, in many cities and towns in the United States all the public utilities—street railways, electric-lighting and gas plants—are controlled by water-power interests.

INTERRELATIONSHIP OF LARGE INTERESTS.

Beyond the marked concentration of ownership already set forth, there is a substantial and growing interrelationship, of greater or less degree, among a number of these large interests that suggests the possibility, if not the probability, of still greater concentration. In other words, not only is there a tendency toward control of public utilities, including water power, by large combinations, but there is a tendency toward a substantial relationship among the combinations themselves. This relationship is established in various ways. In some cases one interest owns stock and has directors in a water-power company that is managed or controlled by another interest; in

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other cases there are directors common to two or more interests that have directors in a third company. Again, a relationship is sometimes established through banking houses. The fact that an individual is a director in two companies does not necessarily point to a close relationship; but it must be admitted that it tends to establish a bond of common interest that might at any time induce and facilitate an actual consolidation.

The two largest and strongest interests in the water-power field, namely, the General Electric Co. and the Stone & Webster interests, show evidence of some degree of relationship. There are several water-power and other public-service corporations under the management of the Stone & Webster Management Association that have upon their boards of directors, or upon the boards of directors of the companies controlling them, men who are also found among the directors of the General Electric companies. The water-power companies involved in this direct connection have a total development of 84,700 h. p. They include the large water-power interests and a number of street railway and lighting companies in the Puget Sound region. Public-service corporations in such important centers as Dallas, Tex., and St. Louis, Mo., are also more or less closely connected with both these large interests.

The S. Morgan Smith, Westinghouse, and Brady interests are connected both through the ownership of securities and through common directors. The Smith and Westinghouse connection is made through the Atlanta Water & Electric Power Co., and the connection between the Westinghouse and Brady interests is through Anthony N. Brady, who is a director in the Westinghouse Electric & Manufacturing Co.

Furthermore, a connection between the Brady, Westinghouse, and General Electric interests is established through representation on the directorate of the Consolidated Gas, Electric Light & Power Co. of Baltimore.

The large group of water powers in the Lower Peninsula of Michigan, which are practically dominated by E. W. Clark & Co. and Hodenpyl and Walbridge interests, are connected through directorates with the Bangor Railway & Electric Co. in Maine, and other public-service corporations controlled by the Hodenpyl and Walbridge banking houses.

Another interrelationship of vast proportions is made through the United Railways Investment Co., which controls the United Railroads and other properties at San Francisco, Cal., and Pittsburgh, Pa. General Electric interests own some securities in the Sierra & San Francisco Power Co. (controlled by the United Railways Investment Co.), and have representation on the board of directors of the Sierra company and also on the board of the United Railroads of

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San Francisco. The United Railways Investment Co. also controls the Philadelphia Co., which, through subsidiaries, controls 14 street railways, a number of electric-light and gaslight companies, and a number of fuel-gas companies in Pittsburgh, Pa., and vicinity.

In this maze of interrelationships, ranging from practically joint control down to personal association in common directorates, is clearly revealed the drift of water-power and public-utility corporations under the control of a few very powerful interests. These connections, some stronger and some weaker, suggest a favorable condition for a very small number of men to consolidate very large interests whenever they may decide it to their advantage to do so. This interlocking of interests through directors, while not necessarily indicating a purpose of monopoly, certainly affords an incentive and a means to combination.

RELATION OF WATER POWER TO THE PUBLIC INTEREST.

It is obvious that such rapid concentration of ownership and control in the water-power industry, as here set forth, involves problems of vital importance to the public welfare. Owing to the comparatively recent development of the "commercial" use of water power, public opinion has not yet had an opportunity to grasp the fundamental principles involved therein. The rapid acquisition of water powers by private interests, and the concentration of control in such hands, more and more limit the field of effective public control and demand the early adoption of some definite policy toward water power. The fundamental problems involved in any such policy are:

1. The best development of the resource.
2. The protection of the consumer.
3. The reservation, for the benefit of the whole public, of its proper share in the advantages inherent in the natural resource itself.

THE BEST DEVELOPMENT OF THE RESOURCE.

The utilization of water power directly tends to conserve the fuel supply of the country, without in any way diminishing the future supply of water power itself, since water power is not decreased by use. The power now (February, 1912) required to operate the industrial enterprises and public-service utilities of the country (excluding steam railroads) probably exceeds 30,000,000 h. p. Approximately 6,000,000 h. p. are now developed by water. It may be conservatively estimated that this represents a saving of at least 33,000,000 tons of coal per year. It is certain that several additional millions of horsepower could be profitably developed from water, thus effecting a still further conservation of coal. It is obvious, therefore, that the early and complete utilization of all commercially

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available water power of the country should be encouraged by every proper means. The real waste of water power is its nonuse. The most efficient utilization of such power, however, tends directly toward concentration of control, through advantages derived from "coupling-up" of sites and markets, unification of storage, and relationships with public-service corporations. This has been already brought out. The problem, therefore, is to reconcile this necessity of full and early development of water power with the proper protection of the public.

IMPRACTICABILITY OF ATTEMPTING TO REGULATE PRICE OF WATER POWER BY ITSELF.

It is true that the efficient utilization of water power tends to produce monopolistic conditions of ownership. But, in addition to this, the "commercial" power industry (that is, the production of power for sale) by its very character involves highly monopolistic tendencies. Therefore, competition can not be relied upon to protect a large portion of the consuming public against unreasonable or unfair charges for power. In the local distribution of power the individual consumer rarely has access to the services of more than one concern. This is because the distribution of power involves an expensive fixed investment, which, as in gas and water, it does not permanently pay to duplicate for purposes of local competition. The result is almost invariably single control, and some public regulation of prices is therefore usually necessary, at least on behalf of the small consumer. This is true of all power, whether generated from fuel or from water. It is not intended in this report to discuss any public regulation of power prices further than to point out the necessity of applying any such public regulation to *all* forms of power. It is especially important to recognize the utter impracticability of applying it to water power alone.

It is self-evident that the price which can be charged for water power can not exceed the price at which fuel power can be sold. On the other hand, experience indicates that the price of water power will not be materially less than this fuel-power price. It might be less if the supply of water power were greater than the market could consume. This, however, rarely happens. Indeed, the Bureau's investigation indicates that the demand for power considerably exceeds that which can be economically produced from water in every considerable section of the country. Therefore the owner of water power has no need, except for the purpose of temporarily effecting an entrance into a market, to reduce his price to a point substantially below the price of fuel power.

Under these conditions it would be impracticable to attempt to force by law the sale of water power at a price less than that of fuel

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power, since this would result in favoring those consumers who obtained water power at this lower price. The benefits of water power would thus merely be transferred from a group of water-power stockholders to a group of water-power buyers. Owing to the insufficient supply of water power, this difficulty would still be encountered even if water power were publicly owned and operated, since some power users would still have to depend upon fuel power. Any attempt to make the price of water power less than the price of fuel power would mean a discrimination between them and those who were able to secure the water-power service. Thus, even under public operation, the only equitable plan of price regulation would be to sell water power at substantially the same price as fuel power.

These conditions clearly demonstrate that it is impracticable to regulate the price of water power as an entirely separate and distinct thing, regardless of the price of fuel power.

THE MAIN PROBLEM OF THE PUBLIC INTEREST ATTACHES TO THE POWER SITE ITSELF.

There remains to be considered the problem of obtaining for the public as a whole its proper share of the advantages inherent in the natural resource itself. As already shown, the public can not hope to get its share of the benefits so inherent in the natural resource by getting the water-power service at less than the price of fuel-power service.

This problem assumes great interest because of the fact that there is still a large amount of undeveloped water power on the public domain, chiefly in the national forests. A rough estimate of such power places the total at 14,000,000 h. p.; the actual total is probably somewhat less. There is also an opportunity for developing a considerable amount of water power in connection with irrigation projects. Some power has, in fact, already been so developed.

A small amount of undeveloped water power, moreover, is still owned by the several States, particularly Illinois and New York, and a considerable amount of water power is directly owned and operated by municipalities.

With respect to the undeveloped water power under the control of the public, either the National Government or the States, it is apparent that an effective policy can be established, by which the public can either itself develop such power or control its development by private parties in such manner as to retain for the public its proper share of the benefits derived from the natural resource. Thus, if the power is developed by the public and sold at the price of fuel power, the public treasury will receive the profit arising therefrom. If, on the other hand, private parties develop and operate

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water powers, the public can still, by charging a proper rental, secure its due share of the benefits inherent in the resource.

The important fact which the Bureau desires to emphasize here is that the one point at which this right of the public can be exercised is in the resource itself, the power site, and not by any attempt to regulate the price of power. Thus, in the case of private operation of water-power privileges, the Government can charge a rental for that right commensurate with the natural advantages of the power site. Such rental, moreover, can be adjusted from time to time to insure the public increased compensation to correspond to any increase in the value of the power site which may arise from increased settlement of the country or other causes. In some cases, of course, a lease without rental charge might be desirable for a limited period, in order to encourage development of inferior sites, which otherwise might not be utilized.

It is not intended to assert that exceptional conditions may not in some cases justify the outright sale of power sites. It is proper to point out, however, that the lease or rental system appears to present distinct advantages, particularly that of retaining in the public hands the ultimate control of the resource. An important consideration in this connection is that, broadly speaking, water power is a resource of an inexhaustible character, and that therein it differs radically from almost all of the other natural resources, which are expended in their using.

Whatever method of control over water-power resources may be deemed most equitable and expedient, it is imperative that a definite policy by both the Federal Government and the States be speedily adopted, first, because of the obvious desirability of utilizing all commercially available water power, and, second, because of the possibility of public water powers passing absolutely into private control.

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PART I

PHYSICAL CONDITIONS AND ECONOMIC ASPECTS OF WATER POWER

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Part I. PHYSICAL CONDITIONS AND ECONOMIC ASPECTS OF WATER POWER.

CHAPTER I.

POWER DEMAND.

Section 1. Introductory.

The water powers of the United States constitute a natural resource of steadily growing importance. Mechanical power is a basic necessity, and our chief present sources of fuel power supply—coal, petroleum, and natural gas—however ample at present, are absolutely fixed in quantity and can not be replaced. Water power is the one important source of mechanical power now practically available which is self-renewing.

Comparatively recent progress in electrical science has greatly increased the public importance of water powers. Electric transmission, as now commercially practicable, allows a given water power to reach a marketing area of at least 100,000 square miles. Under the earlier conditions water power could be utilized only at its site, and its use was therefore greatly circumscribed. Electric transmission has therefore raised water power from a strictly local resource, and has made it available for great communities and wide areas. It has within the last 20 years brought our water-power resources into the category of significant economic forces.

Recognizing the public questions thus involved, this report undertakes to present a view of the economic influences connected with this natural resource and to set forth the results thereof in such a way as to show their significant tendencies and their bearing upon the public interest.

In January, 1909, the Commissioner of Corporations prepared for the President a very brief letter, which accompanied his message vetoing House bill No. 17707, known as the "James River bill." This letter, while noting briefly the growing importance of water power, dealt chiefly with concentration in the control of water-power sites in the hands of a comparatively few interests.

The present report, like that letter, is largely concerned with concentration of ownership. In order, however, to determine the significance of the facts regarding concentration, it is necessary to study the development and growth of power demand, the amount of the stationary installed power in the country, and the amount of developed water power with its relation to the total installed power.

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To complete the survey of pertinent physical facts, there is included a brief chapter on the potential water-power resources of the country. (Unfortunately the data for such discussion are very unsatisfactory.) This is followed by a consideration of some of the problems of water power. These subjects are discussed in Part I. Part II takes up (a) concentration in the control of water power; (b) the relations of certain large interests to water powers, public-service corporations, and financial institutions; and Part III treats of the relation of water power to the public.

The data collected by the Bureau relate to the entire subject of hydroelectric development from the economic point of view, to the ownership of developed water power, the uses of power, and the markets served. The technical and engineering phases of the subject are not considered except in so far as is necessary for the discussion of the economic problems involved. The information relative to some portions of the subject is fragmentary and incomplete. The most important phases, however, such as the amount of developed power, its control, the markets served, and the principal uses to which it is put, were well covered. Representatives of the Bureau visited the sections of the country having the bulk of the water power, and the principal water-power owners. The information thus obtained was checked and supplemented by correspondence and from various published sources.

The statistics of developed water power gathered by this Bureau are almost entirely confined to developments of 1,000 h. p. and above. Although there is, in the aggregate, a great volume of developed water power composed of thousands of small developments under the 1,000 h. p. limit, these powers are generally utilized in small neighborhood enterprises. They are practically negligible in the broad problem of water power.

The statistics of developed water powers in the United States are herein presented by States, by uses, and to some extent by streams. Concentration of ownership is shown in particular localities and also by large interests.

Section 2. The development and growth of the power demand.

DEMAND FOR MANUFACTURING.—In the early years of our industrial history the demand for power came almost entirely from manufacturing enterprises. The demand increased with the increase of manufactures and the use of machinery. It was first met mainly by animal power and water power.

The location of industrial enterprises in the earlier years was largely determined by power sites. The older manufacturing communities, therefore, grew up around water-power sites. But the increase of

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population brought an increased demand for power and it had to be met from other sources. Coincident with this increased demand for power were the development of our transportation facilities, and a change in the forces that determined the location of industry. Formerly, power was a strongly controlling influence. Under the new conditions, however, with better transportation facilities, and steam fuel readily available, the controlling influence was either the accessibility of raw materials or labor or markets for manufactured products, or of all three. Most of the large water-power sites were remote from centers of population. The ease with which steam fuel could be transported for a time minimized the importance of water power.

DEMAND FOR TRACTION AND LIGHTING.—The rapid increase in urban population brought about a large and constantly increasing power demand for street and interurban railways, which have rapidly adopted electrical equipment. Steam railroads also have to a limited extent been introducing electricity.

Electric lighting created a new demand, not confined to the larger communities requiring power for street railways, but coming also from villages and small towns.

Power for lighting and to a considerable extent power for manufactures, domestic use, and miscellaneous purposes, is usually supplied from central stations. By "central stations" are meant plants that produce electricity for sale. This general sale of power is a comparatively recent development, due to the advances of electrical science. The production of power at central stations, like that of electrical power for traction purposes, has grown very rapidly. From 1902 to 1907 the increase in horsepower capacity at central stations was 120 per cent.

MISCELLANEOUS DEMANDS.—A vast volume of power is used in miscellaneous business enterprises, as in the building trades for excavating, hoisting, etc., and in office buildings and hotels for motors, elevators, pumps, etc. While some of the power used for these miscellaneous purposes is obtained from central stations, probably the far greater part of it is developed in plants connected with the buildings themselves. There are, however, no statistics upon which even to estimate its volume.

Section 3. Total demand for stationary power.

It is now necessary to consider the total demand for power as indicated by the volume of power actually used. The discussion here is limited to stationary power. No serious attempt has ever been made to compile complete statistics of the amount of power used by steam railroads and in navigation. The tables in this section are intended to show the total demand for stationary power, as indicated

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by the installed capacity of engines and water wheels in use at different periods, and for different purposes. The data, while not entirely satisfactory, are the best available, and are sufficiently reliable and complete for the general conclusions later based thereon. The statistics used are chiefly those of the United States Bureau of the Census.

INSTALLED PRIME MOVING POWER IN THE UNITED STATES, 1870-1905.—Statistics for water power and steam power used in manufactures have been collected by the Census since 1870, and for the use of gas power in manufactures since 1890. Up to 1890 the manufacturing industries employed the great bulk of stationary prime moving power. Since that date, however, the development of the electrical industry and the application of electricity to lighting and traction purposes have reduced the relative importance of power used in manufactures until now it comprises only about 60 per cent of the reported stationary prime moving power in the country. Recognizing the increase and the importance of the use of power for other purposes, the Bureau of the Census in 1902, and again in 1907, gathered statistics for the electric light and power industry and for street and electric railways, and in 1902 statistics were also gathered for the power used in mines and quarries. Prior to this time the statistics of power used in the latter industry were very incomplete.[1]

The Census classifies power by its *source* and not by its *consumption*. That is to say, some of the power classed under central stations is rented to manufacturing establishments and to electric railways. Consequently the power actually *used* in manufactures and by street railroads is probably more than is indicated by the statistics presented in this section.

POWER CLASSED UNDER MANUFACTURES.—The Census figures for power reported for manufacturing industries will not permit of exact comparisons for the different census years. The industries covered were not the same for all years. By careful analysis, however, it is possible to eliminate the points of difference and to make the revised figures sufficiently comparable for the purposes of this report.[2]

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[1] The tables in this section do not include power generated by certain isolated plants for miscellaneous purposes, such as excavating and hoisting in building operations, and operating elevators and lights in hotels, office buildings, and the like. As an instance of the probable large volume of power thus employed in buildings alone, the Census in 1900 stated that "A recent canvass of New York City by one of the electrical companies showed that the isolated electrical plants in that city represented over 100,000 horsepower thus applied."

[2] The Census of 1870 includes all hand trades and neighborhood industries, including bottling, car and general shop repair by steam railroads, gas manufacture, custom gristmills, custom sawmills, quartz mills, and sugar manufacture on plantations, but excludes cotton ginning.

The Census of 1880 excludes bottling, etc.

The Census of 1890 includes cotton ginning, which was excluded both in 1870 and 1880; it also includes rented as well as owned power, and includes bottling, etc., included in 1870, but excludes sugar manufacture on plantations and quartz mills.

The Census of 1900 includes hand trades and neighborhood industries, including custom gristmills, custom sawmills, and cotton ginning, but excludes rented power, which is stated separately.

The Census of 1905 includes factory industries only, excluding custom gristmills, custom sawmills, cotton ginning, and all hand trade and neighborhood industries.

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The Census figures, moreover, include under the miscellaneous power statistics (that is, those not covered under steam and water power) some secondary power, such as electric motors and pneumatic power. These figures for secondary power must, of course, be eliminated to avoid duplication. The only primary power included in the Census "miscellaneous" figures is that from gas and gasoline, or internal combustion, engines. Electricity and compressed air are but intermediaries in the transmission of energy. Making the necessary modifications of the Census data, the following statement of the total horsepower at each census, classed under manufactures, is obtained:

	Horsepower.
1870	2,346,142
1880	3,410,837
1890	5,845,731
1900	10,613,524
1905	[1] 13,649,614

POWER IN INDUSTRIES OTHER THAN MANUFACTURES.—The preceding discussion has considered only the power classed under manufactures. This included the great bulk of stationary power in use until 1890.

Complete statistics of power used in mines and quarries, including petroleum and natural-gas wells, have been collected only for 1902. The Census statistics for the mining industry for years previous to 1902 appear to be complete only for coal, copper, gold and silver, and iron. They are as follows:

POWER INSTALLED IN MINING COAL, COPPER, GOLD, SILVER, AND IRON, 1870-1902.

Year.	Total horsepower.	Per cent increase.
1870	83,562	.....
1880	194,746	133
1890	386,487	98
1902	1,469,255	280

The power used in these branches of the industry increased 1,658 per cent from 1870 to 1902. The large increase of 280 per cent between the Censuses of 1890 and 1902 is indicative of the rapid increase in the use of power in the mining industry in recent years. The total amount of primary power reported to the Bureau of the Census in 1902 for all branches of the mining and quarrying industry was 2,753,555 h. p. Of course it is impossible to determine the

[1] Power used in the hand trades and neighborhood industries was reported in 1900 but not in 1905. It is practicable to separate from the figures for these industries in 1900 only the power used in custom gristmills, custom sawmill's, and cotton ginneries. This amounted to 884,020 h. p., and this has been added to the figures for 1905 to arrive at an approximate total for that year. The amount of power used in the other neighborhood industries and in the hand trades was comparatively small.

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amount of power used in the entire mining industry in those years for which statistics are not complete. On account of the great liability to error in estimating the unreported power used in other branches prior to 1902, the figures in the consolidated tables presented hereafter are those actually reported. Therefore, for all years except 1902 the figures are too low.

Since 1890 advances in electrical science, particularly in the means of transmitting and applying power, have opened up a very broad market for water power. This is particularly true of electric lighting and traction, the practical commercial development of which has virtually taken place within the last 20 years.

The Census distinguishes power produced by electric railways and that produced for commercial purposes, the latter being supplied through "central stations," already referred to (p. 39). The Census definition of central stations is as follows:

> Plants owned or operated by individuals, companies, corporations, or municipalities and furnishing current for public or commercial uses.

Statistics of power for central stations and electric railways have been collected and compiled by the Census only for 1902 and 1907. The power capacity of plants of central stations and of street and electric railways for the years 1902 and 1907 was as follows:

	1902	1907
	h. p.	*h. p.*
Central stations	1,830,594	4,032,365
Street and electric railways	1,349,211	2,476,479
Total	3,179,805	6,508,844

The figures for street and electric railways include all power of cable and inclined-plane railways, but apparently do not include that of street railways operated by steam locomotives. In 1902, however, the street railways operated by electricity represented 97 per cent of the total mileage of street and electric railways, and they certainly represented an equally large percentage of the total power.

It should be pointed out that a large amount of power used by street railways is not indicated in this and other tables in this chapter, because it is generated by companies other than the street railways themselves. Such power in the Census figures would appear in the total for central stations. For instance, if a street-railway company owned the stock of a power company from which it purchased power, this power would be credited not to street railways, but to central stations.

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TOTAL INSTALLED POWER USED IN MANUFACTURES AND OTHER LEADING INDUSTRIES.—In Table 1 the figures given in the preceding statements in this section are combined, thus giving a grand total of the power installation in manufactures, central stations, street and electric railways, and mines and quarries. There is no duplication in the figures for central stations. Any power generated by electric railway companies and sold is included in the electric railway statistics. The power purchased by street railway companies is excluded. There may be some slight duplication between the total-power figures for mines and quarries and manufactures, but it is so small that it may be ignored here.

As previously explained, this table does not give a complete total of the installed stationary power in the United States, since a considerable volume of power in the aggregate is generated in small, isolated plants not covered by the Census reports. Furthermore, as already noted, statistics were not gathered at each Census for the power used in all manufacturing establishments. The figures for the latest date, therefore, probably understate the total installed power. It should also be kept in mind that the latest figures for mines and quarries are for 1902 and those for manufactures are for 1905, while those for central stations and street and electric railways are for 1907. There has undoubtedly been a very considerable increase in the power used in all these industries since the date of the latest available statistics. The table, however, gives a sufficiently close idea of the development of the power demand in this country during the 35 years ending with 1905.

TABLE 1.—TOTAL PRIME MOVING STATIONARY POWER INSTALLED IN THE UNITED STATES FOR MANUFACTURING, MINING AND QUARRYING, STREET AND ELECTRIC RAILWAYS, AND AT CENTRAL STATIONS, 1870 TO 1905–1907.

[Compiled from reports of the Director of the Census.]

	1870	1880	1890	1900	1905–1907
Manufactures	2,346,142	3,410,837	5,845,731	10,613,524	[1] 13,649,614
Mines and quarries	[2] 114,690	[2] 206,536	[2] 469,307	[2] 2,753,555	[4] 2,753,555
Central stations				[3] 1,830,594	[5] 4,032,365
Street and electric railways				[3] 1,349,211	[5] 2,476,479
Total	2,460,832	3,617,373	6,315,038	16,546,884	22,912,013
Total, exclusive of mines and quarries	2,346,142	3,410,837	5,845,731	13,793,329	20,158,458

[1] See note 1, p. 41.
[2] Data incomplete and figures too low.
[3] 1902.
[4] Figures for 1902 repeated, in absence of actual figures for 1905.
[5] 1907.

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The foregoing table indicates a tremendous increase in the installed stationary power of the country since 1870. The figures for the entire period are complete for manufactures only. Any omissions, however, for the power used in mines and quarries in 1870 would be comparatively small. At that time also no street railways were operated by mechanical power and the central station was unknown. The total for 1870, therefore, includes practically all the stationary power installed at that time. Between 1870 and 1880 steam power was introduced in the operation of street railways by means of cables. Between 1880 and 1890 there was begun the application of electricity to the operation of street railways, and the central station began to occupy a place in the industrial world. The totals shown in the table for 1880 and 1890 do not include any power for street railways nor central stations, nor do they include all the power employed in mining and quarrying. The totals for the country for those years are therefore too small. By the year 1900 great advances had been made in the use of power at central stations and in the operation of street and electric railways, and in 1902 statistics for these industries were gathered for the first time.

The total installed stationary power employed in the United States in manufactures and mines and quarries in 1905, together with that at central stations and in the operation of street and electric railways in 1907, was nearly 23,000,000 h. p. The power used in manufactures increased from over 2,346,000 h. p. in 1870 to nearly 13,650,000 h. p. in 1905. The greatest increase in the use of power for manufacturing purposes was in the decade from 1890 to 1900, when it was 82 per cent. On account of the discrepancies above referred to, no comparisons by periods for the total stationary power used in the industries considered can be made except for the five-year period from 1900 to 1905. Summing up the foregoing facts it appears that during these five years the total stationary horsepower increased from nearly 16,547,000 h. p. to over 22,912,000 h. p., or 38 per cent. It should be kept in mind in making this comparison that the figures for central stations and street and electric railways are for 1902 and 1907.

Section 4. The relation of water power to the total power used.

The previous discussion has considered the total stationary power employed in manufactures and other industries solely with regard to its use. It remains now to consider the source of this power. The relation of water power to the total power installation is shown in Table 2, which distributes the total power among the three primary sources, namely, steam, water, and gas.

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TABLE 2.—INSTALLED PRIME MOVING POWER IN THE UNITED STATES, 1870 TO 1905–1907.

[Expressed in thousands of horsepower.]

	Total.	Steam.		Water.		Gas.	
		H. p.	Per cent of total.	H. p.	Per cent of total.	H. p.	Per cent of total.
1870:							
Manufactures	2,346	1,216	51.8	1,130	48.2	.....	.....
Mines and quarries	[1] 115	115	100.0	.....	.....	.....	.....
Total	2,461	1,331	54.1	1,130	45.9	.....	.....
1880:							
Manufactures	3,410	2,185	64.1	1,225	35.9	.....	.....
Mines and quarries	[1] 207	207	100.0	.....	.....	.....	.....
Total	3,617	2,392	66.1	1,225	33.9	.....	.....
1890:							
Manufactures	5,846	4,582	78.4	1,255	21.5	9	0.1
Mines and quarries	[1] 469	469	100.0	.....	.....	.....	.....
Total	6,315	5,051	80.0	1,255	19.9	9	.1
1900:							
Manufactures	10,618	8,742	82.4	1,727	16.3	144	1.3
Mines and quarries [2]	2,754	2,433	88.4	61	2.2	260	9.4
Central stations [2]	1,830	1,380	75.4	438	23.9	12	.7
Street and electric railways [2]	1,349	1,298	96.2	49	3.6	2	.2
Total	16,546	13,853	83.7	2,275	13.8	418	2.5
1905–1907:							
Manufactures	13,650	11,430	83.7	1,921	14.1	299	2.2
Mines and quarries [3]	2,754	2,433	88.4	61	2.2	260	9.4
Central stations [4]	4,032	2,627	65.1	1,349	33.5	56	1.4
Street and electric railways [4]	2,476	2,368	95.6	92	3.7	16	.7
Total	22,912	18,858	82.3	3,423	14.9	631	2.8

[1] Not classified according to source; assigned entirely to steam power.
[2] 1902.
[3] Figures for 1902 repeated.
[4] 1907.

The table shows that of the power used in manufactures in 1870, water represented over 48 per cent of the prime moving force. In 1880 the increase in the use of steam for manufacturing purposes had so far exceeded the increase in the use of water power that water at that time represented slightly less than 36 per cent of the total prime moving force. At each succeeding Census the increase in the use of steam is shown to have exceeded the increase in the use of water for manufacturing purposes until, in 1905, water represented only 14.1 per cent of the prime moving force. Between 1890 and 1905, the introduction of the internal-combustion engine made gas and gasoline a somewhat important factor in the power situation. In 1890 gas

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engines were reported for the first time and represented 9,000 h. p. used in manufactures. In 1905 they represented 299,000 h. p. used in manufactures, and 631,000 used in all the industries. Comparisons for the five years from 1900 to 1905 can not be well made by totals, for the reason that there are no figures available for power used in mines and quarries in the latter year.

The rate of increase in the various kinds of power used in manufactures from 1870 to 1905, and in that generated at central stations and by street and electric railways from 1902 to 1907, is shown in Table 3. In the preparation of this table the power used in mines and quarries has been eliminated, because complete data are not available.

TABLE 3.—PERCENTAGES OF INCREASE IN VARIOUS KINDS OF POWER, 1870 TO 1905-1907.

	Per cent.			
	Total.	Steam.	Water.	Gas.
Manufactures:				
1870 to 1880	45.4	79.7	8.4	.....
1880 to 1890	71.4	109.7	2.4	.....
1890 to 1900	81.5	90.8	37.6	1,500.0
1900 to 1905	28.6	30.7	11.2	107.6
Central stations, 1902 to 1907	120.3	90.4	208.0	366.7
Street and electric railways, 1902 to 1907	83.5	82.4	87.8	700.0
Total, last 5-year period	46.2	43.8	51.9	134.8

The increase in the use of steam power in manufactures from 1870 to 1880 was nearly 80 per cent, while the increase for water was only 8.4 per cent. From 1880 to 1890 steam power in manufactures increased nearly 110 per cent, while the increase for water power was less than 3 per cent. From 1890 to 1900 steam power in manufactures increased nearly 91 per cent, and water power more than 37 per cent.

During the five years from 1900 to 1905 the total increase of power used in manufactures was 28.6 per cent. The increase in the use of steam was nearly 31 per cent; water power increased about 11 per cent. Power generated by internal-combustion engines increased about 108 per cent, but the absolute increase for this latter source of power was very small, being only 155,000 h. p.

The only satisfactory comparison that can be made for the total power used and for the various classes of industries are those for the five years from 1900 to 1905, or in the case of central stations and street and electric railways from 1902 to 1907. During this five-year period the total power used for all these purposes increased, roughly, 46 per cent. That for manufactures increased 29 per cent. The greatest increase was at central stations, which was 120 per cent, and

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the increase for street railways was 83.5 per cent. The greatest increase in the use of water power was 208 per cent for central stations, thus indicating the tremendous influence that water-power developments are having in the generation and distribution of electricity for lighting and general uses. For the purposes of this report, this is the most significant fact disclosed by the tables so far presented. The street and electric railways in 1902 reported only 49,000 h. p. of water energy. In 1907 this had risen to 92,000, or an increase of 88 per cent. Street railways reported only the power directly owned; it is probable they used considerable water energy purchased from central stations. While the total horsepower from internal-combustion engines is comparatively small, yet its rapid increase suggests the growing importance of this source of power.

Table 2 (p. 45) brings out strikingly the great decline in the relative importance of water power in all industries together, and it also indicates that most of the absolute increase in the use of water power has been due to the development of the electrical industries. The importance of water power in the electrical industries, and the increased use of all forms of power in these industries, are shown in Table 4 below. This table is merely a restatement of data shown in Tables 2 and 3 and is inserted for the purpose of summarizing and emphasizing the facts especially relevant to this discussion.

TABLE 4.—INCREASE IN USE OF POWER IN ELECTRICAL INDUSTRIES, 1902–1907.

	Thousands of horsepower.				Per cent of total.			
	Steam.	Water.	Gas.	Total.	Steam.	Water.	Gas.	Total.
CENTRAL STATIONS.								
1902	1,380	438	12	1,830	75.4	23.9	0.7	100
1907	2,627	1,349	56	4,032	65.1	33.5	1.4	100
Increase	1,247	911	44	2,202				
Per cent of increase	90.4	208.0	366.7	120.3				
STREET AND ELECTRIC RAILWAYS.								
1902	1,298	49	2	1,349	96.2	3.6	.2	100
1907	2,368	92	16	2,476	95.6	3.7	.7	100
Increase	1,070	43	14	1,127				
Per cent of increase	82.4	87.8	700.0	83.5				

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CHAPTER II.

POTENTIAL WATER POWER IN THE UNITED STATES.

Section 1. Difficulty of arriving at correct figures for undeveloped power.

The statistics for undeveloped power are far from satisfactory. In the first place, many of the undeveloped power sites in the United States have never been surveyed or even examined, and in the second place, even where examinations and surveys have been made, the estimates of power are necessarily based upon certain engineering theories that are liable to error. In the investigation conducted in the field by this Bureau no effort was made to secure estimates for undeveloped power, except for those concerns that reported some developed power. Estimates of the undeveloped water power in the United States were prepared (1908) by the United States Geological Survey for the National Conservation Commission. The difficulty of arriving at an accurate estimate was frankly admitted by the Survey:

> The surveys and examinations necessary to a thorough and accurate report of the water-power resources of the United States have never been completed. In certain parts of the country the facts are sufficiently well known to make it possible to present a tolerably accurate statement. In other parts the information is fragmentary, and therefore power estimates must be considered approximate.[1]

LIABILITY TO OVERESTIMATE.—Even in cases where an estimate of power is based upon actual measurements, there is liability of error. It has been proved in actual development that certain factors must be discounted more than is ordinarily done. Where no measurements at all have been made, the liability of error is still greater. These errors usually tend to exaggerate the amount of power. When it is attempted to take storage into account, there is a still further element of error. The volume of storage theoretically possible is seldom practically possible.

A further important consideration is the fact that much water power, although perhaps ultimately available for power purposes, is beyond the range of present commercial probabilities and may properly be disregarded in computing a total for the potential water power. Still again, water that is physically available for the development of power may be more valuable for irrigation or domestic purposes and naturally would be diverted to those uses. The extent of

[1] U. S. Geological Survey, Water-Supply Paper 234, p. 46.

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such diversion of water from power production is, of course, purely conjectural. Large volumes of water are being used for irrigating purposes and to supply the needs of cities, and such use must constantly increase.

Each water-power development is a distinct problem by itself. Preliminary estimates, while usually based in part on available records of stream flow, rainfall, and run-off, are almost always supplemented by additional specific data obtained by engineers. In other words, the preliminary estimate on a specific project is almost certain to be much more accurate than any general estimate for the entire basin in which the project is located. Yet many financial houses identified with hydraulic developments (several of which have their own engineers) state that experience has led them to consider preliminary estimates of power only after dividing by two. If, therefore, it be usual (and it seems to be) for the preliminary estimate on a specific project materially to exceed the power actually developed, it seems more than probable that a general estimate of basins or sections would be even more likely to exceed the actual power eventually obtainable.

Section 2. Estimate of potential water power, not including storage.

Various estimates of potential water power in the United States have been made, but with the exception of that of the United States Geological Survey, above referred to, and other estimates for a few States, they are practically mere guesses.

GEOLOGICAL SURVEY ESTIMATES.—The United States Geological Survey, from the records of stream flow for various periods from 1900 to 1906, and from its own profile maps and those of the United States Army Engineers, and from elevations obtained from railroad and other levels, as well as from various other stream data, prepared in 1908 for the National Conservation Commission an estimate of the total water power (not including storage [1]) in the United States by drainage basins.

The Survey makes it clear that its estimates must be interpreted for future possibilities rather than for present availability. It says:

> For the purposes of this report it has been assumed that all the power in the United States will some day be required. Such an interpretation is the logical one when natural resources are being considered. In other words, the schedule here presented must be interpreted for the future rather than for the present. The reader should not assume that all the power here shown is economically available to-day. Much of it, indeed, would be too costly in development to render it of commercial importance under the present conditions of market and the price of fuel

[1] For a definition of "storage," as here used, see p. 57.

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power. The schedule shows, therefore, what will be the maximum possibilities in the day when our fuel shall have become so exhausted that the price thereof for production of power is prohibitive, and the people of the country shall be driven to the use of all the water power that can reasonably be produced by the streams.[1]

A summary table showing the minimum and assumed maximum development of principal drainage basins as published by the Survey is presented here.

TABLE 5.—ESTIMATE OF STREAM FLOW AND WATER POWER IN THE UNITED STATES, BY DRAINAGE BASINS, EXCLUSIVE OF STORAGE POSSIBILITIES.

[Water-Supply Paper 234, U. S. Geological Survey, 1909. For the Bureau's revision of the figures in this table, see Table 6, p. 55.]

Principal drainages.	Drainage area in square miles.	Flow per annum in billion cubic feet.	Horsepower.	
			Minimum.[1]	Assumed maximum development.[1]
North Atlantic to Cape Henry, Va	159,879	8,942	[2] 1,712,050	[2] 3,186,600
Southern Atlantic to Cape Sable, Fla	123,920	5,560	1,253,000	1,957,800
Eastern Gulf of Mexico to Mississippi River	142,220	6,867	559,000	963,000
Western Gulf of Mexico west of Vermilion River	[3] 433,700	2,232	433,760	822,600
Mississippi River (tributaries from east)	333,600	12,360	[2] 2,619,590	[2] 5,344,600
Mississippi River (tributaries from west, including Vermilion River)	905,200	9,580	3,948,970	7,085,000
St. Lawrence River to Canadian line	[4] 299,720	8,583	[5] 6,682,480	[5] 8,090,000
Colorado River above Yuma, Ariz	225,000	521	2,918,500	5,546,000
Southern Pacific to Point Bonita, Cal	70,700	2,193	3,215,400	7,808,300
Northern Pacific	290,400	15,220	12,979,700	24,701,000
Great Basin	223,000	.....	518,000	801,000
Hudson Bay	62,150	614	75,800	212,600
Total	3,269,489	72,672	36,916,250	66,518,500

[1] For definition of "minimum" and "assumed maximum development," as here used, see p. 52.

[2] Not including area in Pennsylvania. Omission is due to a lack of data for this State at the time the figures were published.

[3] Includes Rio Grande in Mexico.

[4] Includes drainage in Canada.

[5] Includes all of Niagara River, 5,800,000 h. p. minimum and 6,500,000 h. p. assumed maximum.

It should be emphasized at the outset that the figures in the preceding table do not include any allowance for the possibilities arising from artificial storage.

An examination of the details, of which this table is a summary, shows that all the estimated power of the Niagara River is included. More than half of the power of the Niagara River belongs to the Dominion of Canada. Under a treaty between the United States and the British Government only about 25 per cent of the theoretical horsepower of Niagara Falls can be developed. The estimate of

[1] U. S. Geological Survey, Water-Supply Paper 234, p. 47.

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the minimum amount of power that can be developed on the Niagara River above and including the Falls is 5,800,000 h. p., and the assumed maximum is 6,500,000 h. p., all of which is included in the above table. The treaty, therefore, limits present possible minimum development on both sides of the Falls to 1,450,000 h. p. Under the treaty only five-fourteenths of the power made available thereby belongs to the United States, its share being reduced by the diversion of water from Lake Michigan into the Drainage Canal at Chicago.[1] There is thus left at Niagara Falls only about 518,000 h. p. that can at present be developed on the American side. It is necessary, therefore, to revise the Survey totals in accordance with this correction; and further revision should be made by including the power for the streams of Pennsylvania. This, together with some minor revisions for clerical errors, gives the following results:

	Horsepower.	
	Minimum.	Maximum.
Geological Survey estimate, not including Niagara River	31,116,250	60,018,500
Add for Niagara River	518,000	580,000
Add for Pennsylvania streams	331,000	821,000
Add for minor revisions	117,750	258,500
Revised total	32,083,000	61,678,000

A further modification of these estimates should be made for the reason that they are based upon the assumption of 90 per cent efficiency of power on the turbine shaft; that is, on the assumption that 90 per cent of the theoretical energy of the fall will be effective on the turbine shaft, over and above losses in the head race and in the turbine itself. This is too high a basis. In fact, the Geological Survey admittedly made its estimates on the basis of probable future conditions of efficiency of hydraulic equipment. In the report above referred to (p. 48) it is stated:

> Here again, however, we are computing for future conditions, as well as present ones, and it may confidently be expected that, with the improvement of turbines, a greater percentage of the theoretical power will be realized on the shaft and improvements will before long render possible a 90 per cent efficiency.

Some manufacturers of hydraulic equipment express the belief that the limit of efficiency for water turbines has already been practically reached. On this point, however, there is considerable difference of opinion, and other authorities regard an eventual efficiency of 90 per cent as entirely possible. It is absolutely certain, however, that an efficiency of 90 per cent on the turbine shaft is at

[1] For details of conditions at Niagara Falls, see sec. 10, p. 133.

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present too high. Many engineers base their estimates on 80 per cent; in fact, that figure may be said to be the conventional one. In actual practice, however, 75 per cent[1] probably more nearly represents present possibilities than does one of 90 per cent, and this lower standard has been adopted in this report.

There is reason to regard these reduced totals as still too liberal for the potential water power of the country, because of the methods employed in computation. The computations are based on the flow and fall of streams.

In calculating the minimum flow of a stream it is the usual practice of engineers to select the minimum over a long period of years, notwithstanding the fact that water-power installations usually exceed the power indicated by such lowest-record flow.

The estimates for the minimum power, prepared by the Geological Survey, are not on the minimum flow for any day, or even on the lowest average for a very few consecutive days during the entire period covered, but are based on the averages of the minimum flow for the two lowest periods of seven consecutive days in each year for seven years, or less, according to the length of the period for which records were available. It is obvious that such a minimum must be decidedly higher than the absolute minimum for a given day, or the average for a smaller number of consecutive days. This fact was recognized in the estimate of the Geological Survey, but it was stated that the absolute minimum

> * * * is usually of so short duration that it does not equal the practicable minimum that may profitably be installed.

The "assumed maximum development" rests on quite a different basis. As estimated by the Geological Survey, it is based upon the continuous power indicated by the flow of a stream for the six months in the year (not necessarily six consecutive months) showing the highest flow. An average for six months yearly over a period of seven years was taken in all cases where records covering so long a period were available. The actual method was to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum flow for that year. The average of such maximum figures for all years in the period for which data were available is the assumed maximum used in the calculation.

[1] John R. Freeman for the New York State Water Supply Commission employs 75 per cent in his calculations (Fourth Annual Report of New York State Water Supply Commission, p. 257). William G. Fargo usually employs 78 per cent. H. A. E. C. von Schon in Hydro-Electric Practice (1908, p. 8) uses 76 per cent, and Daniel W. Mead in Water Power Engineering (1908, p. 30) gives a table of losses for a hydroelectric plant which gives an efficiency of 76 per cent.

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It was recognized by the Survey as being possible

> that there are parts of the country where the limit should be the highest eight or ten months * * *

but since

> in many parts of the country it has been shown conclusively that it is economical to develop up to that amount which can be had continuously during the highest four months of the year * * * it is believed that the period used (six months) * * * is a very conservative average.

In such an industry as the manufacture of pulp and paper the overdevelopment[1] of streams is practicable. Flood water can be used to grind pulp, which can be stored, and low water can then be utilized to run only the paper machinery. It would seem, nevertheless, that the nine months showing the greatest flow are frequently made the basis for determining the amount of installation. While instances have been encountered where a much shorter flow period has been used as a basis, the experience of the Bureau of Corporations in collecting information from some 700 water-power developments scattered throughout the entire country suggests the use of a longer period than six months. Obviously, as the number of months is increased the average result in power is reduced.

The potential water power estimated by the Survey is undoubtedly further exaggerated by being based, in some cases at least, on 90 per cent of the total fall between two levels. That is to say, if the total fall in a distance of 2 miles, or 10 miles, or any other number of miles, was a given number of feet, 90 per cent of this total fall was multiplied by the stream flow. It is certain that the total amount of power computed for certain sections of streams on this basis of the difference in levels is too high. The nature of the banks of the stream and the most advantageous location of flume or canal and power house are features which frequently determine the location of a dam and consequently the amount of fall that is practically available. For example, 90 per cent of the fall of the Yadkin River from Salisbury, N. C., to the mouth of Uharie River, a distance of 47 miles, is 380 feet. The theoretical minimum discharge of this stream is 2,010 second-feet. The minimum horsepower for this section of the stream, computed from the minimum discharge and fall on a basis of 80 per cent efficiency, is 69,400 h. p.[2] Practically all the available power within these 47 miles is near the point on the stream known as the "Narrows." There is actually being constructed at this point a plant with an installed wheel capacity of 32,000 h. p., and this amount

[1] By "overdevelopment" is meant a larger installation than is warranted by ordinary conditions.

[2] See U. S. Department of Agriculture, Forest Service Circular 144. In this estimate the Forest Service used an efficiency basis of 80 per cent and the exact figures in the circular are here given.

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of power represents practically all that can be advantageously developed within these 47 miles. Thus, the highest practical development in this instance is very much less than the theoretical minimum. It is evident, therefore, that estimates of power based upon the total fall in a long section of a stream are likely to be far above what is practically available. Furthermore, a power development at one site frequently precludes the utilization of a considerable fall in the river above or below that site. What proportion of the theoretical power between two points several miles apart can be utilized can be determined only by an engineer's detailed examination.

Assuming that it is physically possible to develop the theoretical power capacity of a stream, the tremendous cost of such development often forbids it. In the case of the Yadkin River, mentioned above, the cost of the development of the full capacity of that stream over a section of 47 miles makes its utilization impossible.

In view of these facts, with respect to the method of computing theoretical power on the basis of stream flow and fall, and of the economic problem involved in many cases, it is apparent that the estimates shown in Table 5 are too high. It is obviously impossible to measure the degree of error and therefore impossible either for the Survey or for this Bureau to make a definite reduction of the figures, but undoubtedly a considerable reduction should be made for both the minimum and assumed maximum potential power.

From the data furnished by the Geological Survey there has been prepared in this Bureau a table of this power by States. It should be emphasized that this rearrangement is more or less arbitrary. For example, in many cases the drainage basin of a river extends over several States and it is difficult to allot the power possibilities of such a basin among the States involved. It is believed, however, that the distribution made is reasonably accurate. The table shows the power as computed by the Geological Survey on a basis of 90 per cent efficiency, and also on the basis of 75 per cent efficiency, adopted by this Bureau. It should be noted that the total figures given in this table on the basis of 90 per cent are not identical with those originally prepared by the Survey. As previously stated, the estimates of the Survey include nothing for the State of Pennsylvania, whereas they include the entire power of the Niagara River. These figures have been readjusted and minor readjustments have been made in other instances.[1]

[1] See p. 51.

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TABLE 6.—POTENTIAL WATER POWER IN THE UNITED STATES, BY STATES, AS COMPUTED BY THE UNITED STATES GEOLOGICAL SURVEY AND AS REVISED BY THE BUREAU OF CORPORATIONS.

	Potential horsepower on basis of 90 per cent efficiency.		Potential horsepower on basis of 75 per cent efficiency.	
	Minimum.	Assumed maximum.	Minimum.	Assumed maximum.
United States	32,083,000	61,678,000	[1]26,736,000	[1]51,398,000
North Atlantic States:				
Maine	532,000	971,000	443,000	809,000
New Hampshire	162,000	295,000	135,000	246,000
Vermont	113,000	206,000	94,000	172,000
Massachusetts	142,000	273,000	118,000	228,000
Rhode Island	7,000	16,000	6,000	13,000
Connecticut	86,000	164,000	72,000	137,000
New York	1,244,000	2,037,000	1,037,000	1,698,000
New Jersey	53,000	127,000	44,000	106,000
Pennsylvania	331,000	821,000	276,000	684,000
South Atlantic States:				
Delaware	6,000	13,000	5,000	11,000
Maryland	51,000	146,000	43,000	122,000
District of Columbia	6,000	13,000	5,000	11,000
Virginia	590,000	1,044,000	492,000	870,000
West Virginia	457,000	1,261,000	381,000	1,051,000
North Carolina	693,000	1,050,000	578,000	875,000
South Carolina	552,000	812,000	460,000	677,000
Georgia	449,000	752,000	374,000	627,000
Florida	9,000	16,000	8,000	13,000
North Central States:				
Ohio	71,000	213,000	59,000	178,000
Indiana	52,000	141,000	43,000	118,000
Illinois	230,000	414,000	192,000	345,000
Michigan	216,000	352,000	180,000	293,000
Wisconsin	430,000	804,000	358,000	670,000
Minnesota	278,000	593,000	232,000	494,000
Iowa	192,000	458,000	160,000	382,000
Missouri	86,000	195,000	72,000	163,000
North Dakota	105,000	248,000	88,000	207,000
South Dakota	51,000	90,000	43,000	75,000
Nebraska	235,000	439,000	196,000	366,000
Kansas	133,000	323,000	111,000	269,000
South Central States:				
Kentucky	99,000	236,000	83,000	197,000
Tennessee	555,000	913,000	463,000	761,000
Alabama	611,000	1,132,000	509,000	943,000
Mississippi	38,000	75,000	32,000	63,000
Louisiana	1,000	2,000	1,000	2,000
Arkansas	26,000	73,000	22,000	61,000
Oklahoma	90,000	250,000	75,000	208,000
Texas	306,000	661,000	255,000	551,000
Western States:				
Montana	3,299,000	5,197,000	2,749,000	4,331,000
Idaho	1,394,000	3,080,000	1,162,000	2,567,000

[1] This total is arrived at by deducting one-sixth from the total of the 90 per cent efficiency basis; the sum of the items in this column exceeds the total by 7,000 h. p., due to fractional gains in making one-sixth reduction for the individual States.

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TABLE 6.—POTENTIAL WATER POWER IN THE UNITED STATES, BY STATES, AS COMPUTED BY THE UNITED STATES GEOLOGICAL SURVEY AND AS REVISED BY THE BUREAU OF CORPORATIONS—Continued.

	Potential horsepower on basis of 90 per cent efficiency.		Potential horsepower on basis of 75 per cent efficiency.	
	Minimum.	Assumed maximum.	Minimum.	Assumed maximum.
Western States—Continued.				
Wyoming	927,000	1,566,000	773,000	1,305,000
Colorado	1,010,000	2,036,000	842,000	1,697,000
New Mexico	192,000	527,000	160,000	439,000
Arizona	1,071,000	2,038,000	893,000	1,698,000
Utah	892,000	1,581,000	743,000	1,318,000
Nevada	206,000	331,000	172,000	276,000
Washington	5,918,000	10,376,000	4,932,000	8,647,000
Oregon	3,777,000	7,935,000	3,148,000	6,613,000
California	4,109,000	9,382,000	3,424,000	7,818,000
Summary.				
North Atlantic States	2,670,000	4,910,000	[1] 2,225,000	[1] 4,092,000
South Atlantic States	2,813,000	5,107,000	[1] 2,344,000	[1] 4,256,000
North Central States	2,079,000	4,270,000	[1] 1,733,000	[1] 3,558,000
South Central States	1,726,000	3,342,000	[1] 1,438,000	[1] 2,785,000
Western States	22,795,000	44,049,000	[1] 18,996,000	[1] 36,707,000

[1] Computed, as indicated in note on preceding page, by deducting one-sixth from the figures showing potential horsepower on the basis of 90 per cent efficiency.

A notable fact disclosed by the table is the remarkable natural centralization of water power in the United States. Approximately 11,500,000 h. p. (on the 75 per cent efficiency basis), or 43 per cent of the total estimated minimum power of the country is found in the States of California, Oregon, and Washington alone. If we add to this total the power in the three States of Montana, Idaho, and Wyoming, we have in the six States 60 per cent of the total power, and by including the three States of Colorado, Arizona, and Utah, we find in the nine States mentioned 70 per cent of the estimated minimum power in the United States. About 8 per cent of the minimum total is found in the territory in the northeastern section of the country, including Pennsylvania and the States to the north and east. In the area east of the Mississippi River and south of the Ohio River there is about 12 per cent. These three groups of States contain about 90 per cent of the estimated minimum water power of the country, and more than one-third of the remainder is in the four States of Michigan, Wisconsin, Minnesota, and Illinois, bordering on the Great Lakes.

Thus, the great bulk of the water power of the country is situated on what might be termed its edges. The great central basin of the United States has an insignificant percentage. In fact there is but one great water power in all this region, namely, that on the Mississippi River at Keokuk, Iowa.[1]

[1] See p. 165 and Table 8, p. 69.

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Section 3. Storage.

WHAT IS MEANT BY STORAGE.—In the preceding discussion no allowance has been made for storage. By storage, in its broad sense, is meant the gathering of large volumes of water in reservoirs and holding it for considerable time to be released as necessity may require. Of course there is more or less storage, known as "pondage," resulting from power dams. Storage of this character usually affords a reserve of water for a comparatively short time. In developments operated during only a portion of the 24-hour day, the dams accumulate the water while the plant is not in operation and provide a reserve for the next active period. Sometimes this reserve is sufficient to meet deficiencies due to several days of small flow. These dams, however, merely husband the stream flow at the points of development for a few hours or a few days. Distinctive storage developments, on the other hand, accumulate water at the most available gathering points and hold it for months, thus affording a reserve supply through the long periods of low stream flow.

DIFFICULTIES IN BASING ESTIMATES ON STORAGE.—Vairous estimates have been made as to the total water-power possibilities of the United States, including storage, but none of them has been based upon sufficiently reliable data to warrant unquestioned acceptance. The difficulties of estimating the possible power development of a stream are multiplied when an attempt is made to estimate the supplemental reserve force that can be put into it by storage. Not even the authors of such estimates have yet ventured to publish them in detail; they have generally confined themselves to a total for the country or for a drainage basin. Furthermore, different authorities show a wide variation even for comparatively limited areas. For instance, one authority allots to California 11,400,000 h. p., while another allows only 5,000,000. One authority gives Oregon nearly 9,000,000 h. p., another only 3,300,000. One gives New York, Maine, California, Oregon, and Washington a total of 34,000,000 h. p., while other authorities give these States a total of only 17,000,000 h. p.

There are comparatively few distinctively storage developments in the United States. In many engineering problems the engineer can use the actual results of similar work as a basis for estimates, but in computing storage possibilities few if any such results are available. Any estimate including storage, therefore, must be mainly theoretical. Such theoretical computations are likely to give results far in excess of actual possibilities. There are many practical factors that reduce such theoretical power. In the first place, the flow of many streams so fluctuates—that is, the flood is so high and the minimum so low—that a vast storage would be necessary to bring about a reasonably high average of actual power production.

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Such storage may be either physically impossible or its cost may be prohibitive, because of the value of the land which would necessarily be submerged. The New York State Water Supply Commission,[1] for instance, found that the flow of the Delaware River varied from as little as 400 cubic feet per second in extreme drought to 150,000 cubic feet at freshet flow, but that there are not storage facilities of sufficient capacity to hold back the vast volumes of flood water. Again, a stream may have a relatively even flow but so gentle a slope as to render storage impracticable; and still again, power and storage developments may be impracticable because of insufficient foundation for a dam. This is the case with the lower portions of the Grand and Muskegon Rivers in Michigan. Storage possibilities are further limited by the increasing demand for water for other uses, such as irrigation and domestic supplies for cities and towns. It is apparent, therefore, that any estimate based largely upon the theoretical possibilities of the topography of a section must be subject to serious practical error.

In the light of the foregoing considerations, this Bureau is unwilling to suggest any estimate as to the extent to which the water-power possibilities of the country may ultimately be increased by storage or even to cite such estimates as others have made.

Section 4. The relation of minimum potential power to the amount practically developable.

The amount of power that can be economically developed at any given site nearly always exceeds the theoretical minimum. As an illustration, let it be assumed that the minimum power at a given point on a stream is 10,000 h. p., and that this minimum occurs during 60 to 90 days, spread over 5 or 6 months in each year; that during the other months or portions of months there is available at least 15,000 h. p.; and that during 60 to 90 days of the year there is available 20,000 h. p. It is apparent that if only 10,000 h. p. is developed there must be a great waste of energy; a development of 20,000 h. p. would be excessive because that much energy can not be had for a long enough time to warrant the cost; there is 15,000 h. p., however, for 8 or 9 months in the year. It may easily be that it will pay to develop that much and supplement it with steam during the time when only 10,000 h. p. can be had. It is thus seen that the amount of power practically capable of development exceeds the minimum and falls below the maximum.

The above practical considerations, however, do not by any means indicate that a volume of power equal to the estimated minimum for the entire country is economically available for development. It must be kept in mind that a large amount of power is

[1] New York State Water Supply Commission, Fourth Annual Report, p. 209.

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so far from markets or so expensive to develop that the amount available for profitable development in the whole country is probably far less than even the estimated minimum. There is no inconsistency, therefore, in concluding that probably less than the estimated minimum power for the country can be economically utilized for a long time to come.

Section 5. Summary of discussion of potential water power.

The factor of storage certainly exists and may become increasingly important. But for the purposes of this report it is far too incapable of estimate to have any practical place in making comparisons between developed and undeveloped water power. There are enough difficulties in determining the total practical power that can be developed through ordinary methods without attempting to consider storage.

There are reasons for accepting the revised estimates as shown in Table 6, page 55, but with some caution. The admitted tendency toward overestimation of water power; the increasing demand for other and higher uses of water; the constantly increasing disadvantages in the development of the less desirable sites; the increasing efficiency of fuel as a power agency, are all reasons for adopting a conservative estimate of the water that can be regarded as available for power for many years. In the table just referred to the minimum potential water power of the country, on a basis of 75 per cent efficiency, is given as 26,736,000 h. p. and the assumed maximum at 51,398,000 h. p. The maximum certainly overstates the power that is practically and commercially available at present; very probably even the minimum overstates it. It should be constantly remembered in the use of these figures that they include many power sites that are too remote from markets to be utilized for many years to come. As an illustration of this point, attention is directed to the fact that the minimum potential power estimated for California, Idaho, Montana, Oregon, and Washington is 15,415,000 h. p. These States together have developed power to the amount of about 1,000,000 h. p., or less than 7 per cent of their estimated minimum potential power. If the power developed should double each 10 years, it would be 40 years before the minimum potential power of these States was reached. In Oregon it would take more than 50 years, doubling every 10 years, to develop the minimum potential power. Experience does not make it probable that the actual development will be as rapid as this.

In view of actual conditions and in the light of facts that have developed during the course of this investigation, it is evidently but little better than pure speculation to estimate what may be the ultimate water-power development of the country. The only safe ground is to keep within the limits of reasonable possibilities, as indicated above.

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CHAPTER III.

DEVELOPED WATER POWER IN THE UNITED STATES.

Section 1. Introductory.

Complete statistics for the developed water power in the United States were not attempted until 1908. In that year the Bureau of the Census collected statistics by mail for the developed water power of the country, which were compiled for the United States Geological Survey and used in Survey papers prepared for the National Conservation Commission.[1] The Census statistics thus compiled included all water-power developments reported, regardless of size. The total horsepower reported for the United States was 5,356,680. Developments of 1,000 h. p. and over aggregated 3,396,103 h. p., thus leaving 1,960,577 h. p. as being included in developments of less than 1,000 h. p.

The Census figures apparently included all power sites developed and those undeveloped upon which some expenditure had been made.

The statistics of developed power here presented by the Bureau of Corporations include developments under construction down to about the middle of 1911. It is known that in a few instances developments under way are not yet completed. It is probable, however, that some work under construction was not reported and that other developments have been both begun and completed since the collection of the data, so that the net error can be but little. Engineering and financial journals have been widely used to supplement information obtained in the earlier stages of the investigation.

No effort was made by this Bureau to secure data for developments of less than 1,000 h. p., but wherever it was found that a concern had less than 1,000 h. p. developed and owned enough undeveloped power to make a total of 1,000 h. p., or more, such concerns have been included in Table 8.

The installed wheel capacity has been made the basis of the measurement of power in all the tables. It is certain that figures based upon such a measurement somewhat exaggerate the power actually developed. Perhaps in a majority of cases the rated capacity of wheels exceeds the possible power that can be actually produced, and in all cases the installed capacity is greater than the average volume of power that is produced. No other unit of measurement, however, is so satisfactory. Furthermore, statistics heretofore published are

[1] These figures are published in Water-Supply Paper No. 234, U. S. Geological Survey, pp. 32-45.

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based upon wheels and comparison compels the use of the wheel basis. In the comparatively few instances where only the generator capacity was reported it has been converted into wheels by adding one-fourth. Conversion of kilowatts to horsepower has been made by adding one-third to the kilowatt power reported.

In cases of defective schedules information was supplemented by correspondence and interviews and from general engineering and financial sources that were considered reliable.

One of the inquiries in the schedule used by the Bureau related to the uses to which power is put. The answers to this inquiry, while not permitting any detailed statement as to the various uses of power, do allow a division of power into two general classes as to the character of its use. The first class, designated "commercial power," includes all the power developed to sell and not to be used by the developing company, and also the power developed by municipalities, electric light, street railway, and other public-service corporations. The second class, designated "manufacturing power," includes the power developed by manufacturing concerns and used mainly by themselves. While it is not pretended that this division is exact, it is substantially so.

Occasionally groups of manufacturers have formed associations for the development of power sites, each member contributing in proportion to the power used. Again, owners of a manufacturing concern have organized a separate company to develop and supply water power to the manufacturing company. Such developments have been classed under "manufacturing." The power so classed includes some that is used for lighting the establishments of the owners, and a very little that is sold for lighting and other public uses, but the proportion sold is so small as to be almost negligible. Commercial power and manufacturing power are distinguished in Table 8.[1]

Section 2. Total developed water power in the United States.

Excluding developments of less than 1,000 h. p., the total developed water power of the United States, as compiled by the Bureau, is 4,016,127 h. p., of which 2,961,549 h. p. is classed as "commercial" power and 1,054,578 h. p. as "manufacturing." That is to say, 74 per cent of the total power from developments of 1,000 h. p. and over is sold by commercial concerns or used by public-service corporations, and 26 per cent is generated and used by manufacturing concerns. It will be noted that the total wheel development of concerns of 1,000 h. p. and over, as reported to this Bureau, is considerably more than was reported to the Census. Since the statistics of this Bureau are of later date than those collected by the Census, it was to be expected that they would show an increase. The total developed water power

[1] See p. 66.

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of the country, including the developments of less than 1,000 h. p., may be approximately determined by adding the power of these smaller establishments, as reported to the Census, namely, about 2,000,000 h. p., to the developments of 1,000 h. p. and over, as reported to this Bureau. These two figures make a total, in round numbers, of 6,000,000 h. p. It is not probable that any considerable number of developments of less than 1,000 h. p. have been made within the last few years, and the addition of 2,000,000 h. p. to the Bureau's figures undoubtedly approximates very closely the total for the country.

As stated elsewhere, the Bureau has not undertaken to determine the quantity of undeveloped water power in the country, but has merely presented certain estimates prepared by the Geological Survey. During the investigation, however, an effort was made to ascertain, as nearly as possible, the quantity of undeveloped power that is owned by concerns that have some development. It is believed that the undeveloped water power owned by the most important hydroelectric companies of the country has been determined with reasonable accuracy. The undeveloped horsepower, therefore, shown in Table 7, below, and Table 8, page 66, respectively, does not at all represent the undeveloped water power of the country, but simply that owned by hydroelectric and manufacturing concerns that have reported developments.

The developed water power in the United States, including only developments of 1,000 h. p. and over, and the undeveloped power owned or controlled by the concerns reporting developed power, are shown by States in Tables 7 and 8. Table 7 is a summary of water power by States, while Table 8 gives in detail the owners of 3,000 h. p. and over.

TABLE 7.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), BY STATES.[1]

State.	Developed and under construction.		Undeveloped.	Total.
	Commercial.	Manufacturing.		
	h. p.	h. p.	h. p.	h. p.
United States	2,961,549	1,054,578	2,638,528	6,654,655
North Atlantic States:				
Maine	65,360	168,338	100,000	333,698
New Hampshire	16,450	103,658	13,500	133,608
Vermont	53,648	40,197	44,460	138,305
Massachusetts	76,697	53,922	14,620	145,239
Connecticut	32,000	15,519	4,000	51,519
New York	398,058	315,313	193,093	906,464
New Jersey	7,200	.....	.....	7,200
Pennsylvania	169,632	.....	13,142	182,774

[1] Ownership of less than 1,000 h. p. excluded. States omitted from this table had no concerns reporting developed water powers of 1,000 h. p. or over, except as indicated in note 1, p. 63.

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TABLE 7.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), BY STATES—Continued.

State.	Developed and under construction.		Undeveloped.	Total.
	Commercial.	Manufacturing.		
South Atlantic States:	h. p.	h. p.	h. p.	h. p.
Virginia	33,700	17,620	44,800	96,120
West Virginia	5,250	16,150	1,250	22,650
North Carolina	82,960	14,050	61,425	158,435
South Carolina	135,040	47,457	95,585	278,082
Georgia	126,927	12,350	286,350	425,627
Florida	5,000	.....	.....	5,000
North Central States:				
Ohio	4,025	.....	6,675	10,700
Indiana	10,425	4,250	1,000	15,675
Illinois	38,460	12,751	62,100	113,311
Michigan	102,682	30,420	117,650	250,752
Wisconsin	96,799	106,153	91,400	294,352
Minnesota	95,815	72,200	101,600	269,615
Iowa	151,400	.....	151,000	302,400
South Dakota	5,000	.....	3,167	8,167
Kansas	6,800	.....	200	7,000
South Central States:				
Tennessee	62,000	.....	3,862	65,862
Alabama	6,000	10,450	.....	16,450
Western States:				
Montana	139,260	.....	105,700	244,960
Idaho	52,100	.....	42,300	94,400
Colorado	69,690	.....	59,000	128,690
Arizona	16,200	.....	.....	16,200
Utah	52,700	.....	2,600	55,300
Nevada	14,200	.....	24,000	38,200
Washington	300,510	.....	115,700	416,210
Oregon	95,777	.....	143,600	239,377
California	429,467	6,000	732,749	1,168,216
Other States, not enumerated [1]	4,317	7,780	2,000	14,097
Summary.				
North Atlantic States	819,045	696,947	382,815	1,898,807
South Atlantic States	388,877	107,627	489,410	985,914
North Central States	511,406	225,774	534,792	1,271,972
South Central States	68,000	10,450	3,862	82,312
Western States	1,169,904	6,000	1,225,649	2,401,553
Other States, not enumerated [1]	4,317	7,780	2,000	14,097

[1] Embracing one concern in Missouri and four each in Maryland and Rhode Island.

From the above table it is seen that the total horsepower owned by concerns reporting to the Bureau is 6,654,655, of which 4,016,127 h. p. is developed and 2,638,528 h. p. undeveloped. California leads with 14.5 per cent of the "commercial power," developed and under construction, followed by New York with 13.4 per cent, Washington

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with 10.1 per cent, Pennsylvania with 5.7 per cent, Iowa with 5.1 per cent, Montana with 4.7 per cent, South Carolina with 4.6 per cent, Georgia with 4.3 per cent. Ohio has only about 4,000 h. p. developed. Florida, South Dakota, West Virginia, Alabama, Kansas, and New Jersey are next above Ohio with amounts ranging from only 5,000 to 7,200 h. p.

A significant fact brought out in the table is the geographical concentration of water power owned by manufacturers. The five States of Maine, New Hampshire, Vermont, Massachusetts, and Connecticut have 36 per cent of the developed manufacturing power, and New York has 30 per cent, thus giving to these six States 66 per cent, or nearly two-thirds of all the developed manufacturing power in the country. The developed manufacturing power used in these States is found mainly in paper and pulp and cotton manufacturing. Minnesota and Wisconsin together have nearly 17 per cent of the total developed manufacturing power in the country, and this is largely used in the manufacture of pulp and paper. In the Southern States, South Carolina leads with nearly 5 per cent of the total developed manufacturing power in the country, nearly all of which is used in the cotton-manufacturing industry.

The concerns whose ownership is summarized in this table have developed only about three-fifths of the power they own. By far the largest amount of undeveloped power owned by such concerns is found in California, where it amounts to 732,749 h. p. Next is Georgia with 286,350 h. p., then New York with 193,093 h. p., then Iowa with 151,000 h. p., Oregon with 143,600 h. p., Michigan with 117,650 h. p., Washington with 115,700 h. p., Montana with 105,700 h. p., Minnesota with 101,600 h. p., and Maine with 100,000 h. p. These figures for undeveloped power are undoubtedly conservative. Care and some discretion have been exercised in accepting estimates for undeveloped power, and in some instances the estimates of a company have been slightly reduced.

Table 8, page 66, shows in more detail the power included in Table 7. In all cases where the total power reported, including both the developed and undeveloped, is equal to 3,000 h. p. or more, it is shown under the name of the owner. Owners of 1,000 but less than 3,000 h. p. have been grouped.

The table shows approximately the locations and streams of the developments reported by owners of 3,000 h. p. and over.

A map of the United States (opposite p. 84) has been prepared, on which is shown the location of all the water-power developments of 1,000 h. p. and over in the United States, distinguishing commercial and manufacturing power. There are also shown, as indicated by heavy lines, the sections of streams upon which there is power;

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this feature of the map is only approximately exact, and is intended to show in a broad way the sections of country in which, and the particular river systems on which, there is potential power. The length of a power section of a stream is no indication of the amount of power available. A section of 8 or 10 miles in length, on account of flow and fall, may have much more power than a section of 50 or 100 miles with smaller flow and fall.

The map discloses two significant facts with respect to developed powers. First, that practically all of the manufacturing power is in the eastern section of the United States and in the Great Lakes region; and second, that there is practically no power developed in all that section of the country lying in the Mississippi Valley; as already stated there is comparatively little potential power in this region. A study of the map in connection with Table 8 will afford an idea of the relative volume and importance of both the commercial and manufacturing power in various States.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		ALABAMA.	h. p.	h. p.	h. p.	h. p.
Montgomery Light & Water Power Co	30 miles northeast of Montgomery	Tallapoosa River	6,000			6,000
Tallassee Falls Manufacturing Co. (Consolidated Cotton Duck Co.)	Tallassee	do		5,800		5,800
West Point Manufacturing Co	Langdale and River View	Chattahoochee River		4,650		4,650
Total			6,000	10,450		16,450
		ARIZONA.				
Arizona Power Co	Yavapai County	Verde River	9,000			9,000
United States Reclamation Service	Roosevelt Dam	Salt River	7,200			7,200
Total			16,200			16,200
		CALIFORNIA.				
Great Western Power Co	Big Bend and Big Meadows	North Fork of Feather River	60,000		300,000	360,000
Pacific Gas & Electric Co	5 subsidiary companies; 11 plants [1]	Feather, American, and Mokelumne Rivers.	118,343		100,000	218,343
Northern California Power Co. (Cons.)	Fern, Shingleton, Manton, Paynes Creek, and Balls Ferry.	Cow, Battle, and Paynes Creeks	46,900		124,000	170,900
Los Angeles, Bureau of Aqueduct	3 plants in Inyo County	Cottonwood and Division Creeks	2,585		117,415	120,000
Sierra & San Francisco Power Co	Sonora, Subletts Crossing, Tuolumne County.	Stanislaus River	[2] 65,500		50,000	115,500
Pacific Light & Power Corporation	7 plants: Riverside, Borel, Mentone, San Antonio, and Fresno (2 not given).	Kern, Santa Ana, San Gabriel Rivers, San Antonio Creek, Irrigation Ditch, and North Fork San Joaquin River.	[3] 45,400		10,000	55,400

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Southern California Edison Co.	7 plants: 2 at Redlands; 5 not given.	Kern, Mohave, and Santa Ana Rivers.	38,540			38,540
Nevada-California Power Co.	Bishop.	Bishop Creek, tributary to Owens River	15,333		10,667	26,000
Snow Mountain Water & Power Co.	Mendocino County.	Eel River.	8,000		10,000	18,000
Sacramento Valley Power Co.	Redding.	Cow and Snow Creeks.	5,000		10,000	15,000
Mount Whitney Power & Electric Co.	Near Visalia.	Kaweah River.	8,700			8,700
Western States Gas & Electric Co.	Placerville and Junction City.	American and Trinity Rivers.	8,000			8,000
Oro Water, Light & Power Co.	2 plants at Oroville.	West Branch Feather River.		6,000		6,000
Concerns (5) with 1,000 but less than 3,000 h. p.			7,166		667	7,833
Total.			429,467	6,000	732,749	1,168,216
		COLORADO.				
Central Colorado Power Co.	Glenwood Springs, Kremmling, and 30 miles from Denver.	Grand River and Middle Boulder Creek.	39,000		50,000	89,000
Commonwealth Power & Electric Co.	Black Tail Canon.	Grand River.	5,000		5,000	10,000
Telluride Power Co.	Old Ames, New Ames, Ilium, and Ouray.	San Miguel and Gunnison Rivers.	9,450			9,450
San Juan Water & Power Co.	Tacoma.	Animas River.	8,000			8,000
Colorado Springs Light, Heat & Power Co.	Manitou.	Colorado Springs water supply.	3,000		4,000	7,000
Concerns (3) with 1,000 but less than 3,000 h. p.			5,240			5,240
Total.			69,690		59,000	128,690
		CONNECTICUT.				
New York, New Haven & Hartford R. R. Co.[4]	Merwinsville and Danielson.	Housatonic and Quinebaug Rivers.	10,800		2,500	13,300
Hartford Electric Light Co.[5]	Tariffville and Poquonock.	Farmington River.	3,700			3,700
Ponemah Mills.	Taftville.	Shetucket River.		2,500	1,200	3,700
Connecticut River Co.	Windsor Locks.	Connecticut River.	3,500			3,500
Ousatonic Water Power Co.	Shelton and Derby.	Housatonic River.	3,400			3,400
Concerns (14) with 1,000 but less than 3,000 h. p.			10,600	13,019	300	23,919
Total.			32,000	15,519	4,000	51,519

[1] Centerville, De Sabla, Deer Creek, Alta, Newcastle, Electra, Auburn, Folsom City, Yuba City, Colgate, Nevada City.
[2] Includes 3,000 h. p. formerly owned by the San Joaquin Canal & Irrigation Co. at Knight's Ferry, on the Stanislaus River.
[3] Includes the power of the San Joaquin Light & Power Corporation, with 20,450 h. p. developed.
[4] Connecticut Co. and New Milford Power Co.
[5] Leases Farmington River Power Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (whee installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		FLORIDA.	*h. p.*	*h. p.*	*h. p.*	*h. p.*
Florida Power Co	Near Ocala	Withlacoochee River	3,600			3,600
Concerns (1) with 1,000 but less than 3,000 h. p.			1,400			1,400
Total			5,000			5,000
		GEORGIA.				
Central Georgia Power Co	Flovilla	Ocmulgee River	24,000		120,000	144,000
Georgia Power Co	Gainesville and Tallulah Falls	Chattahoochee and Tallulah Rivers	53,250		80,000	133,250
Columbus Power Co	Columbus	Chattahoochee River	11,500		63,500	75,000
Albany Power & Manufacturing Co	Albany	Muckafoonee River	3,500		16,000	19,500
Atlanta Water & Electric Power Co	Dunwoody	Chattahoochee River	16,800			16,800
Augusta, city of	7 miles above city	Savannah River	12,027			12,027
White (Jas.) and family	Barnett Shoals, Athens	Oconee River		1,150	6,850	8,000
Eagle & Phoenix Mills	Columbus	Chattahoochee River		6,400		6,400
Towaliga Falls Power Co	Near Griffin	Towaliga River		3,600		3,600
Concerns (4) with 1,000 but less than 3,000 h. p.			5,850	1,200		7,050
Total			126,927	12,350	286,350	425,627
		IDAHO.				
Telluride Power Co	Grace	Bear River	18,700		21,300	40,000
Idaho Consolidated Power Co	American Falls	Snake River	3,000		17,000	20,000
Washington Water Power Co	Post Falls	Spokane River	18,000			18,000
United States Reclamation Service	Minidoka	Snake River	6,000		4,000	10,000

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Idaho-Oregon Light & Power Co	Payette irrigation ditch	Boise and Snake Rivers	[1] 4,400			4,400
Concerns (1) with 1,000 but less than 3,000 h. p.			2,000			2,000
Total			52,100		42,300	94,400
		ILLINOIS.[2]				
Sanitary district of Chicago	Lockport	Drainage Canal	28,000		48,000	76,000
Marseilles Land & Water Power Co.[3]	Marseilles	Illinois River		7,000	2,000	9,000
United States Arsenal	Rock Island	Mississippi River		2,500	5,100	7,600
Sterling Hydraulic Co.[4]	Sterling	Rock River		3,251	2,000	5,251
Economy Light & Power Co	Near Lockport	Des Plaines River	4,500			4,500
Oregon Power Co	Oregon	Rock River	300		3,000	3,300
Concerns (5) with 1,000 but less than 3,000 h. p.			5,660		2,000	7,660
Total			38,460	12,751	62,100	113,311
		INDIANA.				
Indiana & Michigan Electric Co	Near Elkhart	St. Joseph River	7,000		1,000	8,000
Concerns (5) with 1,000 but less than 3,000 h. p.			3,425	4,250		7,675
Total			10,425	4,250	1,000	15,675
		IOWA.[2]				
Mississippi River Power Co	Keokuk	Mississippi River	150,000		150,000	300,000
Concerns (2) with 1,000 but less than 3,000 h. p.			1,400		1,000	2,400
Total			151,400		151,000	302,400
		KANSAS.				
Spring River Power Co	Lowell	Spring River	5,600			5,600
Concerns (1) with 1,000 but less than 3,000 h. p.			1,200		200	1,400
Total			6,800		200	7,000

[1] Includes 1,200 h. p. leased from Barber Lumber Co.

[2] Power under construction on Mississippi River at Keokuk is all credited to Iowa.

[3] Illinois Traction Co. owner.

[4] A cooperative company composed of all water users on Rock River at Sterling.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		MAINE.				
International Paper Co.	6 plants	Androscoggin River	h. p.	h. p.	h. p.	h. p.
	1 plant	Stillwater River				
	1 plant	Kennebec River		[1] 40,376	29,400	[1] 69,776
	1 plant	Penobscot River				
Central Maine Power Co.	Oakland	Messalonskee River	6,450		23,000	29,450
	Winslow and Pittsfield	Sebasticook River				
Great Northern Paper Co.	Millinocket	Western Branch of Penobscot River		24,500		24,500
Rumford Falls Power Co.	Rumford Falls	Androscoggin River	[2] 20,056		2,200	22,256
St. Croix Paper Co.	Woodland	St. Croix River		11,000	11,000	22,000
Union Water Power Co.[3]	Lewiston	Androscoggin River		18,400	600	19,000
Hollingsworth & Whitney Co.	3 plants at Gardiner	Cobbosseecontee River		15,700	2,000	17,700
	1 at Waterville and 1 at Madison	Kennebec River				
Bangor Railway & Electric Co.	Ellsworth	Union River	4,500		12,000	16,500
	Veazie	Penobscot River				
Pepperell Manufacturing Co.	Biddeford	Saco River		7,000	5,000	12,000
S. D. Warren & Co.	Gardiner, Cumberland Mills, Standish, Westbrook, and Falmouth.	Cobbosseecontee and Presumpscot Rivers.		10,250	1,500	11,750
Pejepscot Paper Co.	Topsham and Lisbon Falls	Androscoggin River		8,581		8,581
Lewiston & Auburn Electric Light Co.	Littlefield, Mechanic Falls, and Auburn.	do	5,540		3,000	8,540
Bodwell Water Power Co.	Oldtown	Penobscot River	7,400		1,000	8,400
Publishers Paper Co.	Bar Mills	Saco River		3,000	4,000	7,000
Portland Electric Co.	Great Falls and West Buxton	Presumpscot and Saco Rivers	6,784			6,784
Shawmut Manufacturing Co.	Shawmut	Kennebec River		4,000		4,000

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Androscoggin Pulp Co.	South Windham and Standish	Presumpscot and Saco Rivers		4,000		4,000
Edwards Manufacturing Co.	Augusta	Kennebec River	[4] 1,000	3,000		4,000
Atlantic Shore Ry	Sanford and Alfred	Mousam River	3,400			3,400
Cabot Manufacturing Co.	Brunswick	Androscoggin River	1,000	2,300		3,300
James Walker Co.	Orono	Penobscot River		3,000		3,000
Concerns (15) with 1,000 but less than 3,000 h. p.			9,230	13,231	5,300	27,761
Total			65,360	168,338	100,000	333,698
		MASSACHUSETTS.				
Holyoke Water Power Co.	Holyoke	Connecticut River	[5] 40,522			[5] 40,522
Essex Company	Lawrence	Merrimac River	20,950			20,950
Turners Falls Co.[6]	Turners Falls	Connecticut River	9,425		6,000	15,425
Proprietors of locks and canals	Lowell	Merrimac River		11,620		11,620
Ludlow Manufacturing Associates	Ludlow	Chicopee River		9,179		9,179
Otis Co.[7]	Ware and Palmer	do		2,959	2,700	5,659
United Electric Light Co.	Indian Orchard and Chicopee	do	4,600	900		5,500
American Woolen Co.	Fitchburg, Maynard, Lowell, Webster, Uxbridge, Blackstone, Colliersville, Lawrence, and South Royalston (10) plants.	Merrimac River (2), Beaver Brook, Blackstone (2), Millers, French, Nashua, Assabet, and Concord Rivers.		5,291		5,291
Hamilton Woolen Co.	3 plants at Amesbury and 7 at Southbridge.	Powow and Quinebaug Rivers		2,980	1,000	3,980
Greenfield Electric Light & Power Co.	Greenfield	Deerfield River	1,200		2,500	3,700
Thorndike Co.[7]	Thorndike and Warren	Ware and Quaboag Rivers		2,989	420	3,409
Concerns (12) with 1,000 but less than 3,000 h. p.				18,004	2,000	20,004
Total			76,697	53,922	14,620	145,239

[1] Does not include 11,006 h. p. of water rented from Rumford Falls Power Co.

[2] Made up of own installation, 2,800 h. p.; and water sold to International Paper Co., 11,006 h. p.; Oxford Paper Co., 5,000 h. p.; and Fort Hill Chemical Co., 1,250 h. p.

[3] This company is owned by the various mill corporations to whom it sells water.

[4] Installation of Cushnoc Paper Co., which buys water from Edwards Manufacturing Co.

[5] 38,322 h. p. installed, 2,200 h. p. under construction.

[6] This company has an installation of 3,000 h. p. and sells 6,425 h. p. to 5 companies having their own wheels. The International Paper Co., with 3,425 h. p., is one of these customers.

[7] Owned by Bliss, Fabyan & Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		MICHIGAN.	h. p.	h. p.	h. p.	h. p.
Commonwealth Power, Railway & Light Co.	Various points (see map of Michigan).	Kalamazoo, Grand, Manistee, Au Sable, Muskegon, and Flat Rivers.	51,800	.....	[1] 71,000	122,800
Michigan Lake Superior Power Co.	Sault Ste. Marie	St. Marys River	18,900	.....	21,100	40,000
Oliver Iron Mining Co.	Iron Mountain	Menominee River	.....	3,850	12,000	15,850
Indiana & Michigan Electric Co.	Buchanan and Berrien Springs	St. Joseph River	9,200	.....	1,000	10,200
Menominee & Marinette Light & Traction Co.	Grand Rapids	Menominee River	4,250	.....	3,800	8,050
Eastern Michigan Edison Co.	Ann Arbor	Huron River	1,500	.....	4,500	6,000
Penn Iron Mining Co.	Vulcan	Menominee River	.....	5,000	.....	5,000
Alpena Power Co. (Ltd.)	Alpena	Thunder Bay River	[2] 2,000	.....	2,500	4,500
Victoria Copper Mining Co.	Victoria	West Branch Ontonagon River	.....	3,600	.....	3,600
Otsego Water Power Co.	Otsego	Kalamazoo River	.....	3,000	.....	3,000
Concerns (21) with 1,000 but less than 3,000 h. p.			15,032	14,970	1,750	31,752
Total			102,682	30,420	117,650	250,752
		MINNESOTA.				
Minneapolis General Electric Co.	St. Croix Falls	St. Croix and Mississippi Rivers	[3] 18,750	.....	[4] 76,250	95,000
Great Northern Power Co.	Near Thompson	St. Louis River	39,000	.....	20,000	59,000
St. Anthony Falls Water Power Co. [5]	Minneapolis	East shore Mississippi River	25,000	7,500	.....	32,500
Minneapolis Mill Co. [5]	.....do	West shore Mississippi River	.....	25,000	.....	25,000
Minnesota & Ontario Power Co.	International Falls	Rainy River	.....	[2] 18,000	.....	18,000
Northwest Paper Co.	Knife Falls, Cloquet, and Brainerd	St. Louis and Mississippi Rivers	.....	[6] 10,700	1,300	12,000
Watab Pulp & Paper Co.	Sartell	Mississippi River	.....	6,000	750	6,750
Consumers Power Co.	Cannon Falls, Mankato, and Red Lake.	Cannon and Blue Earth Rivers	4,115	.....	1,500	5,615

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Little Falls Water Power Co	Little Falls	Mississippi River	[1] 4,100			4,100
Itasca Paper Co	Grand Rapids	do		3,600		3,600
St. Cloud Water Power Co	St. Cloud	do	1,750		1,800	3,550
Concerns (4) with 1,000 but less than 3,000 h. p.			3,100	1,400		4,500
Total			95,815	72,200	101,600	269,615
		MONTANA.				
Butte Electric & Power Co	Divide, Madison, Canyon, Great Falls, Billings, and Livingston.	Big Hole, Madison, Missouri, and Yellowstone Rivers.	69,260		97,600	166,860
United Missouri River Power Co	Canyon Ferry, Hauser Lake, and Holter	Missouri River	65,000			65,000
Northern Idaho & Montana Power Co	Kalispell	Swan River	2,500		8,100	10,600
Concerns (1) with 1,000 but less than 3,000 h. p.			2,500			2,500
Total			139,260		105,700	244,960
		NEVADA.				
Sierra Pacific Electric Co	3 plants near Verdi, 2 near Reno	Truckee River	[2] 14,200		24,000	38,200
		NEW HAMPSHIRE.				
Berlin Mills Co	Berlin and Shelburne	Androscoggin River		31,700	10,000	41,700
International Paper Co	Berlin and Franklin Falls	Androscoggin and Winnepesaukee Rivers.		25,845		25,845
Amoskeag Manufacturing Co	Manchester	Merrimac River	[3] 2,200	20,245		22,445
J. E. Henry & Sons Co	Lincoln and Plymouth	Pemigewassett River		9,885	1,000	10,885
Manchester Traction, Light & Power Co	Garwins Falls, Hookset, Breggs Falls, and Kellys Falls.	Merrimac River	10,000			10,000
Nashua Manufacturing Co	Nashua	Nashua River		4,500		4,500
Concord Electric Co	Concord	Merrimac River	3,050			3,050
Suncook Mills	Suncook	Suncook River		3,000		3,000
Pacific Mills	Dover	Coheco River		1,500	1,500	3,000

[1] Includes 30,000 h. p. on Manistee River probably controlled.
[2] Under construction.
[3] This power developed on Wisconsin side of river.
[4] 70,000 h. p. of this is in Minnesota; the rest undeveloped in Wisconsin.
[5] Stock owned by Pillsbury-Washburn Flour Mills Co. (Ltd.).
[6] 500 h. p. of water sold to city of Brainerd.
[7] 2,100 h. p. of this leased to Hennepin Paper Co.
[8] Includes 2,500 h. p. near Floriston in California.
[9] Sold to Consolidated Cotton Duck Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW HAMPSHIRE—continued.	*h. p.*	*h. p.*	*h. p.*	*h. p.*
Great Falls Manufacturing Co	Somersworth	Salmon Falls River		3,000		3,000
Concerns (5) with 1,000 but less than 3,000 h. p.			1,200	3,983	1,000	6,183
Total			16,450	103,658	13,500	133,608
		NEW JERSEY.				
New Jersey General Security Co	Little Falls, Paterson, and Passaic	Passaic River	7,200			7,200
		NEW YORK.				
Hydraulic Power Co. of Niagara Falls	Niagara Falls	Niagara River	144,000		20,000	164,000
Niagara Falls Power Co	do	do	118,300			118,300
International Paper Co	Brownville, Watertown, Palmer Falls, Ticonderoga, Cadyville, Niagara Falls, South Glens Falls, Fort Edward, and Piercefield.	Ticonderoga, Racquette, Hudson, Black, and Saranac Rivers.		72,333	24,500	96,833
Aluminum Co. of America	Massena Springs	Canal from St. Lawrence River		48,000	48,000	96,000
Hudson River Electric Power Co	Mechanicsville, Spier Falls, and Amsterdam	Hudson River	44,500		15,000	59,500
Utica Gas & Electric Co	Little Falls, Trenton Falls, and Dolgeville.	West and East Canada Creeks and Mohawk River.	11,800		16,200	28,000
Schenectady Power Co. (General Electric Co.)	Johnsonville and Schaghticoke	Hoosic River		26,000		26,000
Rochester Railway & Light Co	Rochester	Genesee River	21,075		2,533	23,608
Hannawa Falls Water Power Co	Potsdam	Racquette River	11,500		2,000	13,500
International Pulp Co	Gouverneur	Oswegatchie River		8,657	4,500	13,157

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Finch, Pruyn & Co	Glens Falls	Hudson River		10,000	2,600	12,600
Aldrich Paper Co	Emeryville and Natural Dam	Oswegatchie River		2,200	10,000	12,200
Gould Paper Co	Lyons Falls	Black River		[1] 4,500	7,600	12,100
St. Regis Paper Co	Deferiet	do		12,000		12,000
East Creek Electric Light & Power Co	East Creek	East Canada Creek	2,100		7,900	10,000
Honk Falls Power Co	Ellenville	Rondout Creek	3,800		6,100	9,900
Remington Martin Co	Norfolk	Raoquette River		5,000	4,500	9,500
Cohoes Co	Cohoes	Mohawk River		7,000	2,000	9,000
Union Bag & Paper Co	Sandy Hill	Hudson River		9,000		9,000
West Virginia Pulp & Paper Co	Mechanicsville	do		8,000		8,000
Watertown Light & Power Co	Watertown	Black River	6,106		1,260	7,366
Paul Smith's Electric Light, Power & R. R. Co.	Paul Smith	Saranac River	3,050		3,600	6,650
Raymondville Paper Co	Raymondville	Racquette River		6,600		6,600
Jefferson Power Co	Black River Village, Dexter, and Herring.	Black River		4,900	1,600	[2] 6,500
Albany Southern R. R	Hudson	Kinderhook Creek	6,320			6,320
United Boxboard Co	Lockport and Schuylerville	Eighteen Mile Creek and Hudson River		5,750		5,750
American Carbide Co	Plattsburg	Saranac River		3,000	1,500	4,500
J. & J. Rogers Co	Black Brook, Ausable Chasm, Au Sable Forks.	Black Brook and Ausable River		4,125		4,125
Iroquois Pulp & Paper Co	McKeever and Thompson	Hudson and Moose Rivers		3,600		3,600
West End Paper Co	Carthage	Black River		2,000	1,500	3,500
Champion Paper Co	do	do		2,600	800	3,400
Oswegatchie Hydraulic Power Co	Near Harrisville	Oswegatchie River	3,400			3,400
Racquette River Paper Co	Potsdam	Racquette River		3,300		3,300
Brownville Board Co	Brownville	Black River		3,221		3,221
American Wood Board Co	Schuylerville	Battenkill		3,200		3,200
Susquehanna River Power Co	Hartwick	Susquehanna River	3,200			3,200
Schroon River Pulp Co	Warrensburg	Schroon River		3,150		3,150
J. P. Lewis Co	Beaver Falls	Beaver River		1,500	1,550	3,050
Oswego Falls Pulp & Paper Co	Fulton	Oswego River		3,000		3,000
A. L. Swett Electric Light & Power Co	Medina	Eighteen Mile Creek	2,200		800	3,000
A. Sherman Lumber Co	Potsdam	Racquette River		3,000		3,000

[1] Some power sold for commercial purposes.

[2] Includes 2,250 h. p. (1,250 installed and 1,000 under construction) owned by interests that control the Jefferson Power Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW YORK—continued.	h. p.	h. p.	h. p.	h. p.
Fulton Paper Co	Fulton	Oswego River		1,500	1,500	3,000
American Woolen Co	do	do		3,000		3,000
Concerns (39) with 1,000 but less than 3,000 h. p.			16,707	45,177	5,550	67,434
Total			398,058	315,313	193,093	906,464
		NORTH CAROLINA.				
Carolina Power & Light Co	Raleigh, Buckhorn Falls, and Blewett Falls near Rockingham.	Neuse, Cape Fear, and Yadkin Rivers	[1] 37,000			[1] 37,000
North Carolina Power & Electric Co	Whitney	Yadkin River	32,000			32,000
Southern Power Co	Pittsboro Duke Mount Holly, Granite Falls, and Lookout Shoals.	Haw River Cape Fear River Catawba River	(2)		31,000	31,000
North Carolina Electrical Power Co	Asheville	French Broad and Ivy Rivers	7,800		7,500	15,300
Roanoke Rapids Power Co	Roanoke Rapids	Roanoke River		4,100	3,900	8,000
Erwin Cotton Mills Co	Cooleemee	Yadkin River		1,750	5,000	6,750
Haywood Electric Power Co	Waynesville	Pigeon River	1,900		3,800	5,700
McAden Mills	McAdenville	South Branch Catawba River		750	3,600	4,350
Asheville Electric Co	Asheville	Hominy Creek	260		3,000	3,260
Concerns (9) with 1,000 but less than 3,000 h. p.			4,000	7,450	3,625	15,075
Total			82,960	14,050	61,425	158,435

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		OHIO.				
United States Government Dam	Zanesville	Muskingum River	2,825	.....	5,675	8,500
Concerns (2) with 1,000 but less than 3,000 h. p.			1,200	.....	1,000	2,200
Total			4,025	.....	6,675	10,700
		OREGON.				
Portland Railway, Light & Power Co	Cazadero, Oregon City, and Silverton.	Clackamas and Willamette Rivers and Silver Creek.	48,000	.....	[1] 75,000	123,000
Mount Hood Railway & Power Co	20 miles east of Portland	Big and Little Sandy Rivers	16,000	.....	50,000	66,000
Idaho-Oregon Light & Power Co	Ox Bow	Snake River	18,600	.....	18,600	37,200
American Power & Light Co	Milton, Tygh Valley, and Hood River.	Walla Walla, White, and Hood Rivers.	7,760	.....	.....	7,760
Concerns (2) with 1,000 but less than 3,000 h. p.			5,417	.....	.....	5,417
Total			95,777	.....	143,600	239,377
		PENNSYLVANIA.				
Pennsylvania Water & Power Co	McCall Ferry	Susquehanna River	135,000	.....	.....	135,000
York Haven Water & Power Co	York Haven	....do	20,000	.....	.....	20,000
Lehigh Coal & Navigation Co	Mauch Chunk	Lehigh River	5,367	.....	5,367	10,734
Schuylkill Navigation Co	Norristown, County Point, Cohocton, Birdsboro, Neversink, Kennedy, and Philadelphia.	Schuylkill River	3,060	.....	4,200	7,260
Pennsylvania Hydro-Electric Co	Warrior Ridge, near Huntington	Juniata River	4,000	.....	1,000	5,000
Concerns (3) with 1,000 but less than 3,000 h. p.			2,205	.....	2,575	4,780
Total			169,632	.....	13,142	182,774
		SOUTH CAROLINA.				
Southern Power Co	Greenville	Saluda River	101,680	.....	73,000	174,680
	Ninety-nine Islands, Wateree	Broad River				
	Catawba, Rocky Creek, and Great Falls	Catawba River				

[1] Includes 32,000 h. p. under construction by the Yadkin River Power Co., formerly the Rockingham Power Co.

[2] See South Carolina for developed power.

[3] Of this 70,000 h. p. is being developed, but since this new development is not all expected to be completed in less than three or four years it is not included in the developed column.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		SOUTH CAROLINA—continued.	h. p.	h. p.	h. p.	h. p.
Electric Manufacturing & Power Co	Gaffney	Broad River	11,620			11,620
Courtenay Manufacturing Co	Newry	Little River		1,130	[1] 7,985	9,115
Columbia Electric Street Railway, Light & Power Co.	Columbia	Broad River	8,140			8,140
Union Manufacturing & Power Co	Neal Shoals	do		8,000		8,000
Pelzer Manufacturing Co	Pelzer	Saluda River		6,500	1,500	8,000
Anderson Water, Light & Power Co	Portman Shoals	Seneca River	7,600			7,600
Lockhart Mills	Lockhart	Broad River		2,800	4,200	7,000
Belton Power Co	10 miles east of Belton	Saluda River		5,000		5,000
Tucapau Mills	Tucapau	Middle and South Forks of Tiger River		2,700	2,000	4,700
Clifton Manufacturing Co	Clifton	Pacolet River		4,160		4,160
Ware Shoals Manufacturing Co	Ware Shoals	Saluda River		3,600		3,600
Pacolet Manufacturing Co	Pacolet	Pacolet River		3,000		3,000
Savannah River Power Co	Gregg Shoals	Savannah River	3,000			3,000
Concerns (10) with 1,000 but less than 3,000 h. p.			3,000	10,567	6,900	20,467
Total			135,040	47,457	95,585	278,082
		SOUTH DAKOTA.				
Consolidated Power & Light Co. of South Dakota	Deadwood	Cheyenne River	2,000		2,500	4,500
	Spearfish	Red Water River				
Sioux Falls Light & Power Co	Sioux Falls	Big Sioux River	3,000		667	3,667
Total			5,000		3,167	8,167

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Chattanooga & Tennessee River Power Co	18 miles west of Chattanooga	Tennessee River	58,800			58,800
Wautauga Power Co	9 miles from Elizabethton	Wautauga River	3,200		3,862	7,062
Total			62,000		3,862	65,862
		UTAH.				
Telluride Power Co	Provo, Jordan Narrows, Logan, and Battle Creek.	Provo, Jordan, and Logan Rivers and Battle Creek.	23,700			23,700
Utah Light & Railway Co	4 plants	Ogden and Weber Rivers and Cottonwood Creek.	14,100		2,600	16,700
Utah-Idaho Sugar Co	Collinston	Bear River	5,600			5,600
Beaver River Power Co	Beaver County	Beaver River	4,500			4,500
Logan Municipal Plant	Logan	Logan River	3,600			3,600
Concerns (1) with 1,000 but less than 3,000 h. p.			1,200			1,200
Total			52,700		2,600	55,300
		VERMONT.				
Connecticut River Power Co. of New Hampshire.	Vernon	Connecticut River	18,000		27,000	45,000
International Paper Co	Bellows Falls and Wilder	do		[2] 19,750		19,750
	Milton	Lamoille River				
Bellows Falls Canal Co	Bellows Falls	Connecticut River	[3] 12,690			12,690
Rutland Railway, Light & Power Co	Rutland	East Branch Otter Creek	2,340		5,160	7,500
Burlington Light & Power Co	Burlington	Winooski River	3,048		4,000	7,048
Consolidated Lighting Co	Montpelier	do	6,150			6,150
Missisquoi Pulp Co	Sheldon Springs	Missisquoi River		5,000	1,000	6,000
Green Mountain Pulp Co	Middlebury	Otter Creek		1,700	3,000	4,700
Vermont Marble Co	Proctor and Center Rutland	do		4,200		4,200
Dalton Paper Mills	Fitzdale	Connecticut River		2,103	2,000	4,103
Claremont Power Co	Cavendish	Black River	2,250		1,000	3,250

[1] Power sites held by Mr. Courtenay or his company on Tugaloo, Keowee, and Little Rivers.

[2] Does not include 9,840 h. p. of water leased from Bellows Falls Canal Co.

[3] Made up of water leased to International Paper Co., 9,840 h. p.; Fall Mountain Electric Light & Power Co., 500 h. p.; 6 manufacturing companies, 2,350 h. p.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		VERMONT—continued.	h. p.	h. p.	h. p.	h. p.
American Woolen Co.	Winooski	Winooski River		2,844	400	3,244
Concerns (10) with 1,000 but less than 3,000 h. p.			9,170	4,600	900	14,670
Total			53,648	40,197	44,460	138,305
		VIRGINIA.				
Fredericksburg Power Co.	Fredericksburg	Rappahannock River	4,500		25,500	30,000
Virginia Railway & Power Co.	Richmond and Petersburg	James and Appomattox Rivers	16,000		3,000	19,000
Lynchburg Water Power Co.	Lynchburg	James River	4,000		7,000	11,000
Riverside & Dan River Cotton Mills (Inc.)	Danville	Dan River		9,270		9,270
Roanoke Traction & Light Co.	Roanoke	Roanoke River	3,000		2,000	5,000
Washington Mills	Fries	New River		2,500	2,500	5,000
Richmond Municipal Water Works & Municipal Electric Plant.	Richmond	James River and Kanawha Canal	3,050		1,650	4,700
Bedford Pulp & Paper Co.	....do	James River		3,400		3,400
Emporia Hydro-Electric Corporation	Emporia	Meherrin River	1,800		1,200	3,000
Concerns (4) with 1,000 but less than 3,000 h. p.			1,350	2,450	1,950	5,750
Total			33,700	17,620	44,800	96,120
		WASHINGTON.				
Washington Water Power Co.	Spokane and Little Falls	Spokane River	[1] 133,000		24,000	157,000
Pacific Coast Power Co.	Electron and Snoqualmie Falls	Puyallup, Snoqualmie, and White Rivers.	[2] 77,000		53,000	130,000
Seattle Municipal Light & Power Plant	Cedar Lake	Cedar River	[3] 20,800		14,200	35,000

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Tacoma Municipal [illegible]	La Grande	Nisqually River	[illegible]			
Wenatchee Valley Gas & Electric Co	Wenatchee	Entiat River and minor streams	4,730		15,000	19,730
Great Northern Ry. Co	Leavenworth	Wenatchee River	8,000		4,500	12,500
Spokane & Inland Empire R. R	Near Spokane	Spokane River	12,000			12,000
Whatcom County Railway & Light Co	Mount Baker	Nooksack River	3,300		5,000	8,300
American Power & Light Co	Naches, North Yakima, White Salmon, and Priest Rapids.	White Salmon, Columbia, and Naches Rivers.	8,080			8,080
Concerns (1) with 1,000 but less than 3,000 h. p.			1,600			1,600
Total			300,510		115,700	416,210
		WEST VIRGINIA.				
Electro-Metallurgical Co	Kanawha Falls and Glen Ferris	Kanawha River		11,750		11,750
Martinsburg Power Co	15 miles from Martinsburg	Potomac River	2,250		1,250	3,500
Winchester & Washington City Ry. Co	30 miles from Winchester	Shenandoah River	3,000			3,000
Harpers Ferry Paper Co	Harpers Ferry	Shenandoah and Potomac Rivers		[5] 4,400		4,400
Total			5,250	16,150	1,250	22,650
		WISCONSIN.				
Green Bay & Mississippi Canal Co	9 plants: Little Rapids, Combined Locks, Appleton, Little Chute, Kaukauna, Rapide de Croche.	Fox River	22,835		9,200	32,035
Chippewa Valley Railway, Light & Power Co	Eau Claire and Menomonie	Chippewa and Red Cedar Rivers	[6] 16,900		9,000	25,900
Kimberly-Clark Co	6 plants: Neenah 2, Kimberly, Niagara, and Appleton 2.	Menominee and Fox Rivers		13,450		13,450
Alexander Stewart Lumber Co. and R. L. Krause.	Wausau and Lower Grandfather Falls.	Wisconsin River		500	11,800	12,300
Chippewa Lumber & Boom Co	Chippewa Falls	Chippewa River		2,656	9,400	12,056
Lacrosse Water Power Co	Hatfield and Ross Eddy	Black River	8,000		4,000	12,000

[1] 13,000 h. p. installed; 120,000 h. p. under construction.
[2] 50,000 h. p. installed; 27,000 h. p. under construction.
[3] 4,800 h. p. installed; 16,000 h. p. under construction.
[4] Under construction.
[5] Includes 2,000 h. p. of Shenandoah Pulp Co., which has same president, treasurer, secretary, and general manager as Harpers Ferry Paper Co.
[6] Does not include 750 h. p. leased from Dells Paper & Pulp Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		MAINE.				
International Paper Co.	6 plants	Androscoggin River	h. p.	h. p.	h. p.	h. p.
	1 plant	Stillwater River		[1] 40,376	29,400	[1] 69,776
	1 plant	Kennebec River				
	1 plant	Penobscot River				
Central Maine Power Co.	Oakland	Messalonskee River	6,450		23,000	29,450
	Winslow and Pittsfield	Sebasticook River				
Great Northern Paper Co.	Millinocket	Western Branch of Penobscot River		24,500		24,500
Rumford Falls Power Co.	Rumford Falls	Androscoggin River	[2] 20,056		2,200	22,256
St. Croix Paper Co.	Woodland	St. Croix River		11,000	11,000	22,000
Union Water Power Co.[3]	Lewiston	Androscoggin River		18,400	600	19,000
Hollingsworth & Whitney Co.	3 plants at Gardiner	Cobbosseecontee River		15,700	2,000	17,700
	1 at Waterville and 1 at Madison	Kennebec River				
Bangor Railway & Electric Co.	Ellsworth	Union River	4,500		12,000	16,500
	Veazie	Penobscot River				
Pepperell Manufacturing Co.	Biddeford	Saco River		7,000	5,000	12,000
S. D. Warren & Co.	Gardiner, Cumberland Mills, Standish, Westbrook, and Falmouth.	Cobbosseecontee and Presumpscot Rivers.		10,250	1,500	11,750
Pejepscot Paper Co.	Topsham and Lisbon Falls	Androscoggin River		8,581		8,581
Lewiston & Auburn Electric Light Co.	Littlefield, Mechanic Falls, and Auburn.	do	5,540		3,000	8,540
Bodwell Water Power Co.	Oldtown	Penobscot River	7,400		1,000	8,400
Publishers Paper Co.	Bar Mills	Saco River		3,000	4,000	7,000
Portland Electric Co.	Great Falls and West Buxton	Presumpscot and Saco Rivers	6,784			6,784
Shawmut Manufacturing Co.	Shawmut	Kennebec River		4,000		4,000

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Androscoggin Pulp Co.	South Windham and Standish	Presumpscot and Saco Rivers		4,000		4,000
Edwards Manufacturing Co.	Augusta	Kennebec River	[4] 1,000	3,000		4,000
Atlantic Shore Ry	Sanford and Alfred	Mousam River	3,400			3,400
Cabot Manufacturing Co.	Brunswick	Androscoggin River	1,000	2,300		3,300
James Walker Co.	Orono	Penobscot River		3,000		3,000
Concerns (15) with 1,000 but less than 3,000 h. p.			9,230	13,231	5,300	27,761
Total			65,360	168,338	100,000	333,698
		MASSACHUSETTS.				
Holyoke Water Power Co.	Holyoke	Connecticut River	[5] 40,522			[5] 40,522
Essex Company	Lawrence	Merrimac River	20,950			20,950
Turners Falls Co.[6]	Turners Falls	Connecticut River	9,425		6,000	15,425
Proprietors of locks and canals	Lowell	Merrimac River		11,620		11,620
Ludlow Manufacturing Associates	Ludlow	Chicopee River		9,179		9,179
Otis Co.[7]	Ware and Palmer	do		2,959	2,700	5,659
United Electric Light Co.	Indian Orchard and Chicopee	do	4,600	900		5,500
American Woolen Co.	Fitchburg, Maynard, Lowell, Webster, Uxbridge, Blackstone, Collidersville, Lawrence, and South Royalston (10) plants.	Merrimac River (2), Beaver Brook, Blackstone (2), Millers, French, Nashua, Assabet, and Concord Rivers.		5,291		5,291
Hamilton Woolen Co.	3 plants at Amesbury and 7 at Southbridge.	Powow and Quinebaug Rivers		2,980	1,000	3,980
Greenfield Electric Light & Power Co.	Greenfield	Deerfield River	1,200		2,500	3,700
Thorndike Co.[7]	Thorndike and Warren	Ware and Quaboag Rivers		2,989	420	3,409
Concerns (12) with 1,000 but less than 3,000 h. p.				18,004	2,000	20,004
Total			76,697	53,922	14,620	145,239

[1] Does not include 11,006 h. p. of water rented from Rumford Falls Power Co.

[2] Made up of own installation, 2,800 h. p.; and water sold to International Paper Co., 11,006 h. p.; Oxford Paper Co., 5,000 h. p.; and Fort Hill Chemical Co., 1,250 h. p.

[3] This company is owned by the various mill corporations to whom it sells water.

[4] Installation of Cushnoc Paper Co., which buys water from Edwards Manufacturing Co.

[5] 38,322 h. p. installed, 2,200 h. p. under construction.

[6] This company has an installation of 3,000 h. p. and sells 6,425 h. p. to 5 companies having their own wheels. The International Paper Co., with 3,425 h. p., is one of these customers.

[7] Owned by Bliss, Fabyan & Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		MICHIGAN.	h. p.	h. p.	h. p.	h. p.
Commonwealth Power, Railway & Light Co.	Various points (see map of Michigan).	Kalamazoo, Grand, Manistee, Au Sable, Muskegon, and Flat Rivers.	51,800	.....	[1]71,000	122,800
Michigan Lake Superior Power Co.	Sault Ste. Marie	St. Marys River	18,900	.....	21,100	40,000
Oliver Iron Mining Co.	Iron Mountain	Menominee River	.....	3,850	12,000	15,850
Indiana & Michigan Electric Co.	Buchanan and Berrien Springs	St. Joseph River	9,200	.....	1,000	10,200
Menominee & Marinette Light & Traction Co.	Grand Rapids	Menominee River	4,250	.....	3,800	8,050
Eastern Michigan Edison Co.	Ann Arbor	Huron River	1,500	.....	4,500	6,000
Penn Iron Mining Co.	Vulcan	Menominee River	.....	5,000	.....	5,000
Alpena Power Co. (Ltd.)	Alpena	Thunder Bay River	[2]2,000	.....	2,500	4,500
Victoria Copper Mining Co.	Victoria	West Branch Ontonagon River	.....	3,600	.....	3,600
Otsego Water Power Co.	Otsego	Kalamazoo River	.....	3,000	.....	3,000
Concerns (21) with 1,000 but less than 3,000 h. p.	.....	.....	15,032	14,970	1,750	31,752
Total	.....	.....	102,682	30,420	117,650	250,752
		MINNESOTA.				
Minneapolis General Electric Co.	St. Croix Falls	St. Croix and Mississippi Rivers	[3]18,750	.....	[4]76,250	95,000
Great Northern Power Co.	Near Thompson	St. Louis River	39,000	.....	20,000	59,000
St. Anthony Falls Water Power Co. [5]	Minneapolis	East shore Mississippi River	25,000	7,500	.....	32,500
Minneapolis Mill Co. [5]	....do	West shore Mississippi River	.....	25,000	.....	25,000
Minnesota & Ontario Power Co.	International Falls	Rainy River	.....	[2]18,000	.....	18,000
Northwest Paper Co.	Knife Falls, Cloquet, and Brainerd	St. Louis and Mississippi Rivers	.....	[6]10,700	1,300	12,000
Watab Pulp & Paper Co.	Sartell	Mississippi River	.....	6,000	750	6,750
Consumers Power Co.	Cannon Falls, Mankato, and Red Lake.	Cannon and Blue Earth Rivers	4,115	.....	1,500	5,615

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Little Falls Water Power Co	Little Falls	Mississippi River	[7] 4,100			4,100
Itasca Paper Co	Grand Rapids	do		3,600		3,600
St. Cloud Water Power Co	St. Cloud	do	1,750		1,800	3,550
Concerns (4) with 1,000 but less than 3,000 h. p.			3,100	1,400		4,500
Total			95,815	72,200	101,600	269,615
		MONTANA.				
Butte Electric & Power Co	Divide, Madison, Canyon, Great Falls, Billings, and Livingston.	Big Hole, Madison, Missouri, and Yellowstone Rivers.	69,260		97,600	166,860
United Missouri River Power Co	Canyon Ferry, Hauser Lake, and Holter	Missouri River	65,000			65,000
Northern Idaho & Montana Power Co	Kalispell	Swan River	2,500		8,100	10,600
Concerns (1) with 1,000 but less than 3,000 h. p.			2,500			2,500
Total			139,260		105,700	244,960
		NEVADA.				
Sierra Pacific Electric Co	3 plants near Verdi, 2 near Reno	Truckee River	[8] 14,200		24,000	38,200
		NEW HAMPSHIRE.				
Berlin Mills Co	Berlin and Shelburne	Androscoggin River		31,700	10,000	41,700
International Paper Co	Berlin and Franklin Falls	Androscoggin and Winnepesaukee Rivers.		25,845		25,845
Amoskeag Manufacturing Co	Manchester	Merrimac River	[9] 2,200	20,245		22,445
J. E. Henry & Sons Co	Lincoln and Plymouth	Pemigewassett River		9,885	1,000	10,885
Manchester Traction, Light & Power Co	Garwins Falls, Hookset, Breggs Falls, and Kellys Falls.	Merrimac River	10,000			10,000
Nashua Manufacturing Co	Nashua	Nashua River		4,500		4,500
Concord Electric Co	Concord	Merrimac River	3,050			3,050
Suncook Mills	Suncook	Suncook River		3,000		3,000
Pacific Mills	Dover	Coheco River		1,500	1,500	3,000

[1] Includes 30,000 h. p. on Manistee River probably controlled.
[2] Under construction.
[3] This power developed on Wisconsin side of river.
[4] 70,000 h. p. of this is in Minnesota; the rest undeveloped in Wisconsin.
[5] Stock owned by Pillsbury-Washburn Flour Mills Co. (Ltd.).
[6] 500 h. p. of water sold to city of Brainerd.
[7] 2,100 h. p. of this leased to Hennepin Paper Co.
[8] Includes 2,500 h. p. near Floriston in California.
[9] Sold to Consolidated Cotton Duck Co.

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Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW HAMPSHIRE—continued.	h. p.	h. p.	h. p.	h. p.
Great Falls Manufacturing Co	Somersworth	Salmon Falls River		3,000		3,000
Concerns (5) with 1,000 but less than 3,000 h. p.			1,200	3,983	1,000	6,183
Total			16,450	103,658	13,500	133,608
		NEW JERSEY.				
New Jersey General Security Co	Little Falls, Paterson, and Passaic	Passaic River	7,200			7,200
		NEW YORK.				
Hydraulic Power Co. of Niagara Falls	Niagara Falls	Niagara River	144,000		20,000	164,000
Niagara Falls Power Co	do	do	118,300			118,300
International Paper Co	Brownville, Watertown, Palmer Falls, Ticonderoga, Cadyville, Niagara Falls, South Glens Falls, Fort Edward, and Piercefield.	Ticonderoga, Racquette, Hudson, Black, and Saranac Rivers.		72,333	24,500	96,833
Aluminum Co. of America	Massena Springs	Canal from St. Lawrence River		48,000	48,000	96,000
Hudson River Electric Power Co	Mechanicsville, Spier Falls, and Amsterdam	Hudson River	44,500		15,000	59,500
Utica Gas & Electric Co	Little Falls, Trenton Falls, and Dolgeville.	West and East Canada Creeks and Mohawk River.	11,800		16,200	28,000
Schenectady Power Co. (General Electric Co.)	Johnsonville and Schaghticoke	Hoosic River		26,000		26,000
Rochester Railway & Light Co	Rochester	Genesee River	21,075		2,533	23,608
Hannawa Falls Water Power Co	Potsdam	Racquette River	11,500		2,000	13,500
International Pulp Co	Gouverneur	Oswegatchie River		8,657	4,500	13,157

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Finch, Pruyn & Co	Glens Falls	Hudson River		10,000	2,600	12,600
Aldrich Paper Co	Emeryville and Natural Dam	Oswegatchie River		2,200	10,000	12,200
Gould Paper Co	Lyons Falls	Black River		[1] 4,500	7,600	12,100
St. Regis Paper Co	Deferiet	do		12,000		12,000
East Creek Electric Light & Power Co	East Creek	East Canada Creek	2,100		7,900	10,000
Honk Falls Power Co	Ellenville	Rondout Creek	3,800		6,100	9,900
Remington Martin Co	Norfolk	Racquette River		5,000	4,500	9,500
Cohoes Co	Cohoes	Mohawk River		7,000	2,000	9,000
Union Bag & Paper Co	Sandy Hill	Hudson River		9,000		9,000
West Virginia Pulp & Paper Co	Mechanicsville	do		8,000		8,000
Watertown Light & Power Co	Watertown	Black River	6,106		1,260	7,366
Paul Smith's Electric Light, Power & R. R. Co.	Paul Smith	Saranac River	3,050		3,600	6,650
Raymondville Paper Co	Raymondville	Racquette River		6,600		6,600
Jefferson Power Co	Black River Village, Dexter, and Herring.	Black River		4,900	1,600	[2] 6,500
Albany Southern R. R	Hudson	Kinderhook Creek	6,320			6,320
United Boxboard Co	Lockport and Schuylerville	Eighteen Mile Creek and Hudson River		5,750		5,750
American Carbide Co	Plattsburg	Saranac River		3,000	1,500	4,500
J. & J. Rogers Co	Black Brook, Ausable Chasm, Au Sable Forks.	Black Brook and Ausable River		4,125		4,125
Iroquois Pulp & Paper Co	McKeever and Thompson	Hudson and Moose Rivers		3,600		3,600
West End Paper Co	Carthage	Black River		2,000	1,500	3,500
Champion Paper Co	do	do		2,600	800	3,400
Oswegatchie Hydraulic Power Co	Near Harrisville	Oswegatchie River	3,400			3,400
Racquette River Paper Co	Potsdam	Racquette River		3,300		3,300
Brownville Board Co	Brownville	Black River		3,221		3,221
American Wood Board Co	Schuylerville	Battenkill		3,200		3,200
Susquehanna River Power Co	Hartwick	Susquehanna River	3,200			3,200
Schroon River Pulp Co	Warrensburg	Schroon River		3,150		3,150
J. P. Lewis Co	Beaver Falls	Beaver River		1,500	1,550	3,050
Oswego Falls Pulp & Paper Co	Fulton	Oswego River		3,000		3,000
A. L. Swett Electric Light & Power Co	Medina	Eighteen Mile Creek	2,200		800	3,000
A. Sherman Lumber Co	Potsdam	Racquette River		3,000		3,000

[1] Some power sold for commercial purposes.

[2] Includes 2,250 h. p. (1,250 installed and 1,000 under construction) owned by interests that control the Jefferson Power Co.

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Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW YORK—continued.	h. p.	h. p.	h. p.	h. p.
Fulton Paper Co	Fulton	Oswego River		1,500	1,500	3,000
American Woolen Co	do	do		3,000		3,000
Concerns (39) with 1,000 but less than 3,000 h. p.			16,707	45,177	5,550	67,434
Total			398,058	315,313	193,093	906,464
		NORTH CAROLINA.				
Carolina Power & Light Co	Raleigh, Buckhorn Falls, and Blewett Falls near Rockingham.	Neuse, Cape Fear, and Yadkin Rivers	[1] 37,000			[1] 37,000
North Carolina Power & Electric Co	Whitney	Yadkin River	32,000			32,000
Southern Power Co	Pittsboro	Haw River	[2]		31,000	31,000
	Duke	Cape Fear River				
	Mount Holly, Granite Falls, and Lookout Shoals.	Catawba River				
North Carolina Electrical Power Co	Asheville	French Broad and Ivy Rivers	7,800		7,500	15,300
Roanoke Rapids Power Co	Roanoke Rapids	Roanoke River		4,100	3,900	8,000
Erwin Cotton Mills Co	Cooleemee	Yadkin River		1,750	5,000	6,750
Haywood Electric Power Co	Waynesville	Pigeon River	1,900		3,800	5,700
McAden Mills	McAdenville	South Branch Catawba River		750	3,600	4,350
Asheville Electric Co	Asheville	Hominy Creek	260		3,000	3,260
Concerns (9) with 1,000 but less than 3,000 h. p.			4,000	7,450	3,625	15,075
Total			82,960	14,050	61,425	158,435

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		OHIO.				
United States Government Dam	Zanesville	Muskingum River	2,825	.....	5,675	8,500
Concerns (2) with 1,000 but less than 3,000 h. p.			1,200	.....	1,000	2,200
Total			4,025	.....	6,675	10,700
		OREGON.				
Portland Railway, Light & Power Co	Cazadero, Oregon City, and Silverton.	Clackamas and Willamette Rivers and Silver Creek.	48,000	.....	[1] 75,000	123,000
Mount Hood Railway & Power Co	20 miles east of Portland	Big and Little Sandy Rivers	16,000	.....	50,000	66,000
Idaho-Oregon Light & Power Co	Ox Bow	Snake River	18,600	.....	18,600	37,200
American Power & Light Co	Milton, Tygh Valley, and Hood River.	Walla Walla, White, and Hood Rivers.	7,760	.....	.....	7,760
Concerns (2) with 1,000 but less than 3,000 h. p.			5,417	.....	.....	5,417
Total			95,777	.....	143,600	239,377
		PENNSYLVANIA.				
Pennsylvania Water & Power Co	McCall Ferry	Susquehanna River	135,000	.....	.....	135,000
York Haven Water & Power Co	York Haven	....do	20,000	.....	.....	20,000
Lehigh Coal & Navigation Co	Mauch Chunk	Lehigh River	5,367	.....	5,367	10,734
Schuylkill Navigation Co	Norristown, County Point, Cohocton, Birdsboro, Neversink, Kennedy, and Philadelphia.	Schuylkill River	3,060	.....	4,200	7,260
Pennsylvania Hydro-Electric Co	Warrior Ridge, near Huntington	Juniata River	4,000	.....	1,000	5,000
Concerns (3) with 1,000 but less than 3,000 h. p.			2,205	.....	2,575	4,780
Total			169,632	.....	13,142	182,774
		SOUTH CAROLINA.				
Southern Power Co	Greenville	Saluda River	101,680	.....	73,000	174,680
	Ninety-nine Islands, Wateree	Broad River				
	Catawba, Rocky Creek, and Great Falls	Catawba River				

[1] Includes 32,000 h. p. under construction by the Yadkin River Power Co., formerly the Rockingham Power Co.

[2] See South Carolina for developed power.

[3] Of this 70,000 h. p. is being developed, but since this new development is not all expected to be completed in less than three or four years it is not included in the developed column.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		SOUTH CAROLINA—continued.	h. p.	h. p.	h. p.	h. p.
Electric Manufacturing & Power Co	Gaffney	Broad River	11,620			11,620
Courtenay Manufacturing Co	Newry	Little River		1,130	[1] 7,985	9,115
Columbia Electric Street Railway, Light & Power Co.	Columbia	Broad River	8,140			8,140
Union Manufacturing & Power Co	Neal Shoals	do		8,000		8,000
Pelzer Manufacturing Co	Pelzer	Saluda River		6,500	1,500	8,000
Anderson Water, Light & Power Co	Portman Shoals	Seneca River	7,600			7,600
Lockhart Mills	Lockhart	Broad River		2,800	4,200	7,000
Belton Power Co	10 miles east of Belton	Saluda River		5,000		5,000
Tucapau Mills	Tucapau	Middle and South Forks of Tiger River		2,700	2,000	4,700
Clifton Manufacturing Co	Clifton	Pacolet River		4,160		4,160
Ware Shoals Manufacturing Co	Ware Shoals	Saluda River		3,600		3,600
Pacolet Manufacturing Co	Pacolet	Pacolet River		3,000		3,000
Savannah River Power Co	Gregg Shoals	Savannah River	3,000			3,000
Concerns (10) with 1,000 but less than 3,000 h. p.			3,000	10,567	6,900	20,467
Total			135,040	47,457	95,585	278,082
		SOUTH DAKOTA.				
Consolidated Power & Light Co. of South Dakota	Deadwood	Cheyenne River	2,000		2,500	4,500
	Spearfish	Red Water River				
Sioux Falls Light & Power Co	Sioux Falls	Big Sioux River	3,000		667	3,667
Total			5,000		3,167	8,167

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		TENNESSEE.				
Chattanooga & Tennessee River Power Co	18 miles west of Chattanooga	Tennessee River	58,800			58,800
Wautauga Power Co	9 miles from Elizabethton	Wautauga River	3,200		3,862	7,062
Total			62,000		3,862	65,862
		UTAH.				
Telluride Power Co	Provo, Jordan Narrows, Logan, and Battle Creek.	Provo, Jordan, and Logan Rivers and Battle Creek.	23,700			23,700
Utah Light & Railway Co	4 plants	Ogden and Weber Rivers and Cottonwood Creek.	14,100		2,600	16,700
Utah-Idaho Sugar Co	Collinston	Bear River	5,600			5,600
Beaver River Power Co	Beaver County	Beaver River	4,500			4,500
Logan Municipal Plant	Logan	Logan River	3,600			3,600
Concerns (1) with 1,000 but less than 3,000 h. p.			1,200			1,200
Total			52,700		2,600	55,300
		VERMONT.				
Connecticut River Power Co. of New Hampshire.	Vernon	Connecticut River	18,000		27,000	45,000
International Paper Co	Bellows Falls and Wilder	do		[2] 19,750		19,750
	Milton	Lamoille River				
Bellows Falls Canal Co	Bellows Falls	Connecticut River	[3] 12,690			12,690
Rutland Railway, Light & Power Co	Rutland	East Branch Otter Creek	2,340		5,160	7,500
Burlington Light & Power Co	Burlington	Winooski River	3,048		4,000	7,048
Consolidated Lighting Co	Montpelier	do	6,150			6,150
Missisquoi Pulp Co	Sheldon Springs	Missisquoi River		5,000	1,000	6,000
Green Mountain Pulp Co	Middlebury	Otter Creek		1,700	3,000	4,700
Vermont Marble Co	Proctor and Center Rutland	do		4,200		4,200
Dalton Paper Mills	Fitzdale	Connecticut River		2,103	2,000	4,103
Claremont Power Co	Cavendish	Black River	2,250		1,000	3,250

[1] Power sites held by Mr. Courtenay or his company on Tugaloo, Keowee, and Little Rivers.

[2] Does not include 9,840 h. p. of water leased from Bellows Falls Canal Co.

[3] Made up of water leased to International Paper Co., 9,840 h. p.; Fall Mountain Electric Light & Power Co., 500 h. p.; 6 manufacturing companies, 2,350 h. p.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		VERMONT—continued.				
			h. p.	h. p.	h. p.	h. p.
American Woolen Co.	Winooski	Winooski River		2,844	400	3,244
Concerns (10) with 1,000 but less than 3,000 h. p.			9,170	4,600	900	14,670
Total			53,648	40,197	44,460	138,305
		VIRGINIA.				
Fredericksburg Power Co.	Fredericksburg	Rappahannock River	4,500		25,500	30,000
Virginia Railway & Power Co.	Richmond and Petersburg	James and Appomattox Rivers	16,000		3,000	19,000
Lynchburg Water Power Co.	Lynchburg	James River	4,000		7,000	11,000
Riverside & Dan River Cotton Mills (Inc.)	Danville	Dan River		9,270		9,270
Roanoke Traction & Light Co.	Roanoke	Roanoke River	3,000		2,000	5,000
Washington Mills	Fries	New River		2,500	2,500	5,000
Richmond Municipal Water Works & Municipal Electric Plant.	Richmond	James River and Kanawha Canal	3,050		1,650	4,700
Bedford Pulp & Paper Co.	do	James River		3,400		3,400
Emporia Hydro-Electric Corporation	Emporia	Meherrin River	1,800		1,200	3,000
Concerns (4) with 1,000 but less than 3,000 h. p.			1,350	2,450	1,950	5,750
Total			33,700	17,620	44,800	96,120
		WASHINGTON.				
Washington Water Power Co.	Spokane and Little Falls	Spokane River	[1] 133,000		24,000	157,000
Pacific Coast Power Co.	Electron and Snoqualmie Falls	Puyallup, Snoqualmie, and White Rivers.	[2] 77,000		53,000	130,000
Seattle Municipal Light & Power Plant	Cedar Lake	Cedar River	[3] 20,800		14,200	35,000

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Tacoma Municipal Plant	La Grande	Nisqually River	[4] 22,000			
Wenatchee Valley Gas & Electric Co	Wenatchee	Entiat River and minor streams	4,730		15,000	19,730
Great Northern Ry. Co	Leavenworth	Wenatchee River	8,000		4,500	12,500
Spokane & Inland Empire R. R	Near Spokane	Spokane River	12,000			12,000
Whatcom County Railway & Light Co	Mount Baker	Nooksack River	3,300		5,000	8,300
American Power & Light Co	Naches, North Yakima, White Salmon, and Priest Rapids.	White Salmon, Columbia, and Naches Rivers.	8,080			8,080
Concerns (1) with 1,000 but less than 3,000 h. p.			1,600			1,600
Total			300,510		115,700	416,210
		WEST VIRGINIA.				
Electro-Metallurgical Co	Kanawha Falls and Glen Ferris	Kanawha River		11,750		11,750
Martinsburg Power Co	15 miles from Martinsburg	Potomac River	2,250		1,250	3,500
Winchester & Washington City Ry. Co	30 miles from Winchester	Shenandoah River	3,000			3,000
Harpers Ferry Paper Co	Harpers Ferry	Shenandoah and Potomac Rivers		[5] 4,400		4,400
Total			5,250	16,150	1,250	22,650
		WISCONSIN.				
Green Bay & Mississippi Canal Co	9 plants: Little Rapids, Combined Locks, Appleton, Little Chute, Kaukauna, Rapide de Croche.	Fox River	22,835		9,200	32,035
Chippewa Valley Railway, Light & Power Co	Eau Claire and Menomonie	Chippewa and Red Cedar Rivers	[6] 16,900		9,000	25,900
Kimberly-Clark Co	6 plants: Neenah 2, Kimberly, Niagara, and Appleton 2.	Menominee and Fox Rivers		13,450		13,450
Alexander Stewart Lumber Co. and R. L. Krause.	Wausau and Lower Grandfather Falls	Wisconsin River		500	11,800	12,300
Chippewa Lumber & Boom Co	Chippewa Falls	Chippewa River		2,656	9,400	12,056
Lacrosse Water Power Co	Hatfield and Ross Eddy	Black River	8,000		4,000	12,000

[1] 13,000 h. p. installed; 120,000 h. p. under construction.
[2] 50,000 h. p. installed; 27,000 h. p. under construction.
[3] 4,800 h. p. installed; 16,000 h. p. under construction.
[4] Under construction.
[5] Includes 2,000 h. p. of Shenandoah Pulp Co., which has same president, treasurer, secretary, and general manager as Harpers Ferry Paper Co.
[6] Does not include 750 h. p. leased from Dells Paper & Pulp Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		WISCONSIN—continued.				
			h. p.	h. p.	h. p.	h. p.
Southern Wisconsin Power Co	Kilbourn	Wisconsin River	8,000		4,000	12,000
Nekoosa-Edwards Paper Co	Nekoosa and Port Edwards	do		[1] 10,700		10,700
Northern Hydro-Electric Co	Near Marinette	Peshtigo River	10,500			10,500
Wausau Street R. R. Co	Wausau	Wisconsin River	2,700		6,500	9,200
Bradley estate	Nigger Island, Kings, and Grandmother Falls.	do		250	8,850	9,100
Consolidated Water Power & Paper Co	Grand Rapids	do		9,000		9,000
Dells Paper & Pulp Co	Eau Claire	Chippewa River	1,000	7,529		8,529
Menominee River Boom Co	Pemene Dam	Menominee River	6,000		2,500	8,500
Menasha Woodenware Co	Near Ladysmith	Chippewa and Flambeau Rivers	2,600		5,600	8,200
Arpin Lumber Co	Bellils Falls, Bruce, and Radisson	Chippewa River		3,500	4,000	7,500
Tomahawk Paper & Pulp Co	Township 34 north, range 4 east	Wisconsin River		7,129		7,129
St. Croix Power Co	Apple River Falls	Apple River	5,600			5,600
Wisconsin River Pulp & Paper Co	Stevens Point	Wisconsin River		5,300		5,300
Marathon Paper Mills Co	Rothschild	do		[2] 5,000		5,000
Grand Rapids Pulp & Paper Co	Biron	do		4,950		4,950
Ashland Light, Power & Street Railway Co	Ashland	White River	1,800		3,000	4,800
Wausau Paper Mills Co	Brokaw	Wisconsin River		4,756		4,756
Menasha Paper Co	Ladysmith	Flambeau River		4,400		4,400
Peshtigo Lumber Co	Peshtigo and Caldron Falls	Peshtigo River		1,390	2,800	4,190
Rhinelander Paper Co	Oneida County	Wisconsin River		4,137		4,137
Merrill Railway & Lighting Co. (Kings Electric Co.).	Merrill and Lower Falls	do	3,900			3,900
Plover Paper Co	Plover and Stevens Point	do		1,900	2,000	3,900

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Centralia Pulp & Water Power Co.	Grand Rapids	do		2,800	1,000	3,800
Grandfather Falls Co.	Merrill and Grandfather Falls	do		1,816	1,800	3,616
Neenah-Menasha Water Power Co.	Menasha	Fox River		3,000		3,000
Concerns (14) with 1,000 but less than 3,000 h. p.			6,964	11,990	5,950	24,904
Total			96,799	106,153	91,400	294,352
		ALL OTHER STATES.[3]				
Concerns (9) with 1,000 but less than 3,000 h. p.			4,317	7,780	2,000	14,097

[1] Small amount for lighting.
[2] Under construction.
[3] Embracing one concern in Missouri and four concerns each in Maryland and Rhode Island.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		MICHIGAN.				
			h. p.	h. p.	h. p.	h. p.
Commonwealth Power, Railway & Light Co.	Various points (see map of Michigan).	Kalamazoo, Grand, Manistee, Au Sable, Muskegon, and Flat Rivers.	51,800	.....	[1]71,000	122,800
Michigan Lake Superior Power Co.	Sault Ste. Marie	St. Marys River	18,900	.....	21,100	40,000
Oliver Iron Mining Co.	Iron Mountain	Menominee River	.....	3,850	12,000	15,850
Indiana & Michigan Electric Co.	Buchanan and Berrien Springs	St. Joseph River	9,200	.....	1,000	10,200
Menominee & Marinette Light & Traction Co.	Grand Rapids	Menominee River	4,250	.....	3,800	8,050
Eastern Michigan Edison Co.	Ann Arbor	Huron River	1,500	.....	4,500	6,000
Penn Iron Mining Co.	Vulcan	Menominee River	.....	5,000	.....	5,000
Alpena Power Co. (Ltd.)	Alpena	Thunder Bay River	[2]2,000	.....	2,500	4,500
Victoria Copper Mining Co.	Victoria	West Branch Ontonagon River	.....	3,600	.....	3,600
Otsego Water Power Co.	Otsego	Kalamazoo River	.....	3,000	.....	3,000
Concerns (21) with 1,000 but less than 3,000 h. p.	.....	.....	15,032	14,970	1,750	31,752
Total	.....	.....	102,682	30,420	117,650	250,752
		MINNESOTA.				
Minneapolis General Electric Co.	St. Croix Falls	St. Croix and Mississippi Rivers	[3]18,750	.....	[4]76,250	95,000
Great Northern Power Co.	Near Thompson	St. Louis River	39,000	.....	20,000	59,000
St. Anthony Falls Water Power Co. [5]	Minneapolis	East shore Mississippi River	25,000	7,500	.....	32,500
Minneapolis Mill Co. [5]	.....do	West shore Mississippi River	.....	25,000	.....	25,000
Minnesota & Ontario Power Co.	International Falls	Rainy River	.....	[2]18,000	.....	18,000
Northwest Paper Co.	Knife Falls, Cloquet, and Brainerd	St. Louis and Mississippi Rivers	.....	[6]10,700	1,300	12,000
Watab Pulp & Paper Co.	Sartell	Mississippi River	.....	6,000	750	6,750
Consumers Power Co.	Cannon Falls, Mankato, and Red Lake.	Cannon and Blue Earth Rivers	4,115	.....	1,500	5,615

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Little Falls Water Power Co	Little Falls	Mississippi River	[7] 4,100			4,100
Itasca Paper Co	Grand Rapids	do		3,600		3,600
St. Cloud Water Power Co	St. Cloud	do	1,750		1,800	3,550
Concerns (4) with 1,000 but less than 3,000 h. p.			3,100	1,400		4,500
Total			95,815	72,200	101,600	269,615
		MONTANA.				
Butte Electric & Power Co	Divide, Madison, Canyon, Great Falls, Billings, and Livingston.	Big Hole, Madison, Missouri, and Yellowstone Rivers.	69,260		97,600	166,860
United Missouri River Power Co	Canyon Ferry, Hauser Lake, and Holter	Missouri River	65,000			65,000
Northern Idaho & Montana Power Co	Kalispell	Swan River	2,500		8,100	10,600
Concerns (1) with 1,000 but less than 3,000 h. p.			2,500			2,500
Total			139,260		105,700	244,960
		NEVADA.				
Sierra Pacific Electric Co	3 plants near Verdi, 2 near Reno	Truckee River	[8] 14,200		24,000	38,200
		NEW HAMPSHIRE.				
Berlin Mills Co	Berlin and Shelburne	Androscoggin River		31,700	10,000	41,700
International Paper Co	Berlin and Franklin Falls	Androscoggin and Winnepesaukee Rivers.		25,845		25,845
Amoskeag Manufacturing Co	Manchester	Merrimac River	[9] 2,200	20,245		22,445
J. E. Henry & Sons Co	Lincoln and Plymouth	Pemigewassett River		9,885	1,000	10,885
Manchester Traction, Light & Power Co	Garwins Falls, Hookset, Breggs Falls, and Kellys Falls.	Merrimac River	10,000			10,000
Nashua Manufacturing Co	Nashua	Nashua River		4,500		4,500
Concord Electric Co	Concord	Merrimac River	3,050			3,050
Suncook Mills	Suncook	Suncook River		3,000		3,000
Pacific Mills	Dover	Coheco River		1,500	1,500	3,000

[1] Includes 30,000 h. p. on Manistee River probably controlled.
[2] Under construction.
[3] This power developed on Wisconsin side of river.
[4] 70,000 h. p. of this is in Minnesota; the rest undeveloped in Wisconsin.
[5] Stock owned by Pillsbury-Washburn Flour Mills Co. (Ltd.).
[6] 500 h. p. of water sold to city of Brainerd.
[7] 2,100 h. p. of this leased to Hennepin Paper Co.
[8] Includes 2,500 h. p. near Floriston in California.
[9] Sold to Consolidated Cotton Duck Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW HAMPSHIRE—continued.	h. p.	h. p.	h. p.	h. p.
Great Falls Manufacturing Co	Somersworth	Salmon Falls River		3,000		3,000
Concerns (5) with 1,000 but less than 3,000 h. p.			1,200	3,983	1,000	6,183
Total			16,450	103,658	13,500	133,608
		NEW JERSEY.				
New Jersey General Security Co	Little Falls, Paterson, and Passaic	Passaic River	7,200			7,200
		NEW YORK.				
Hydraulic Power Co. of Niagara Falls	Niagara Falls	Niagara River	144,000		20,000	164,000
Niagara Falls Power Co	do	do	118,300			118,300
International Paper Co	Brownville, Watertown, Palmer Falls, Ticonderoga, Cadyville, Niagara Falls, South Glens Falls, Fort Edward, and Piercefield.	Ticonderoga, Raoquette, Hudson, Black, and Saranac Rivers.		72,333	24,500	96,833
Aluminum Co. of America	Massena Springs	Canal from St. Lawrence River		48,000	48,000	96,000
Hudson River Electric Power Co	Mechanicsville, Spier Falls, and Amsterdam	Hudson River	44,500		15,000	59,500
Utica Gas & Electric Co	Little Falls, Trenton Falls, and Dolgeville.	West and East Canada Creeks and Mohawk River.	11,800		16,200	28,000
Schenectady Power Co. (General Electric Co.)	Johnsonville and Schaghticoke	Hoosic River		26,000		26,000
Rochester Railway & Light Co	Rochester	Genesee River	21,075		2,533	23,608
Hannawa Falls Water Power Co	Potsdam	Racquette River	11,500		2,000	13,500
International Pulp Co	Gouverneur	Oswegatchie River		8,657	4,500	13,157

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Finch, Pruyn & Co	Glens Falls	Hudson River		10,000	2,600	12,600
Aldrich Paper Co	Emeryville and Natural Dam	Oswegatchie River		2,200	10,000	12,200
Gould Paper Co	Lyons Falls	Black River		[1] 4,500	7,600	12,100
St. Regis Paper Co	Deferiet	do		12,000		12,000
East Creek Electric Light & Power Co	East Creek	East Canada Creek	2,100		7,900	10,000
Honk Falls Power Co	Ellenville	Rondout Creek	3,800		6,100	9,900
Remington Martin Co	Norfolk	Racquette River		5,000	4,500	9,500
Cohoes Co	Cohoes	Mohawk River		7,000	2,000	9,000
Union Bag & Paper Co	Sandy Hill	Hudson River		9,000		9,000
West Virginia Pulp & Paper Co	Mechanicsville	do		8,000		8,000
Watertown Light & Power Co	Watertown	Black River	6,106		1,260	7,366
Paul Smith's Electric Light, Power & R. R. Co	Paul Smith	Saranac River	3,050		3,600	6,650
Raymondville Paper Co	Raymondville	Racquette River		6,600		6,600
Jefferson Power Co	Black River Village, Dexter, and Herring.	Black River		4,900	1,600	[2] 6,500
Albany Southern R. R	Hudson	Kinderhook Creek	6,320			6,320
United Boxboard Co	Lockport and Schuylerville	Eighteen Mile Creek and Hudson River		5,750		5,750
American Carbide Co	Plattsburg	Saranac River		3,000	1,500	4,500
J. & J. Rogers Co	Black Brook, Ausable Chasm, Au Sable Forks.	Black Brook and Ausable River		4,125		4,125
Iroquois Pulp & Paper Co	McKeever and Thompson	Hudson and Moose Rivers		3,600		3,600
West End Paper Co	Carthage	Black River		2,000	1,500	3,500
Champion Paper Co	do	do		2,600	800	3,400
Oswegatchie Hydraulic Power Co	Near Harrisville	Oswegatchie River	3,400			3,400
Racquette River Paper Co	Potsdam	Racquette River		3,300		3,300
Brownville Board Co	Brownville	Black River		3,221		3,221
American Wood Board Co	Schuylerville	Battenkill		3,200		3,200
Susquehanna River Power Co	Hartwick	Susquehanna River	3,200			3,200
Schroon River Pulp Co	Warrensburg	Schroon River		3,150		3,150
J. P. Lewis Co	Beaver Falls	Beaver River		1,500	1,550	3,050
Oswego Falls Pulp & Paper Co	Fulton	Oswego River		3,000		3,000
A. L. Swett Electric Light & Power Co	Medina	Eighteen Mile Creek	2,200		800	3,000
A. Sherman Lumber Co	Potsdam	Racquette River		3,000		3,000

[1] Some power sold for commercial purposes.

[2] Includes 2,250 h. p. (1,250 installed and 1,000 under construction) owned by interests that control the Jefferson Power Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		NEW YORK—continued.	h. p.	h. p.	h. p.	h. p.
Fulton Paper Co	Fulton	Oswego River		1,500	1,500	3,000
American Woolen Co	do	do		3,000		3,000
Concerns (39) with 1,000 but less than 3,000 h. p.			16,707	45,177	5,550	67,434
Total			398,058	315,313	193,093	906,464
		NORTH CAROLINA.				
Carolina Power & Light Co	Raleigh, Buckhorn Falls, and Blewett Falls near Rockingham.	Neuse, Cape Fear, and Yadkin Rivers	[1] 37,000			[1] 37,000
North Carolina Power & Electric Co	Whitney	Yadkin River	32,000			32,000
Southern Power Co	Pittsboro	Haw River	(2)		31,000	31,000
	Duke	Cape Fear River				
	Mount Holly, Granite Falls, and Lookout Shoals.	Catawba River				
North Carolina Electrical Power Co	Asheville	French Broad and Ivy Rivers	7,800		7,500	15,300
Roanoke Rapids Power Co	Roanoke Rapids	Roanoke River		4,100	3,900	8,000
Erwin Cotton Mills Co	Cooleemee	Yadkin River		1,750	5,000	6,750
Haywood Electric Power Co	Waynesville	Pigeon River	1,900		3,800	5,700
McAden Mills	McAdenville	South Branch Catawba River		750	3,600	4,350
Asheville Electric Co	Asheville	Hominy Creek	260		3,000	3,260
Concerns (9) with 1,000 but less than 3,000 h. p.			4,000	7,450	3,625	15,075
Total			82,960	14,050	61,425	158,435

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		OHIO.				
United States Government Dam	Zanesville	Muskingum River	2,825	.....	5,675	8,500
Concerns (2) with 1,000 but less than 3,000 h. p.			1,200	.....	1,000	2,200
Total			4,025	.....	6,675	10,700
		OREGON.				
Portland Railway, Light & Power Co	Cazadero, Oregon City, and Silverton.	Clackamas and Willamette Rivers and Silver Creek.	48,000	.....	[3] 75,000	123,000
Mount Hood Railway & Power Co	20 miles east of Portland	Big and Little Sandy Rivers	16,000	.....	50,000	66,000
Idaho-Oregon Light & Power Co	Ox Bow	Snake River	18,600	.....	18,600	37,200
American Power & Light Co	Milton, Tygh Valley, and Hood River.	Walla Walla, White, and Hood Rivers.	7,760	.....	.....	7,760
Concerns (2) with 1,000 but less than 3,000 h. p.			5,417	.....	.....	5,417
Total			95,777	.....	143,600	239,377
		PENNSYLVANIA.				
Pennsylvania Water & Power Co	McCall Ferry	Susquehanna River	135,000	.....	.....	135,000
York Haven Water & Power Co	York Haven	....do	20,000	.....	.....	20,000
Lehigh Coal & Navigation Co	Mauch Chunk	Lehigh River	5,367	.....	5,367	10,734
Schuylkill Navigation Co	Norristown, County Point, Cohocton, Birdsboro, Neversink, Kennedy, and Philadelphia.	Schuylkill River	3,060	.....	4,200	7,260
Pennsylvania Hydro-Electric Co	Warrior Ridge, near Huntington	Juniata River	4,000	.....	1,000	5,000
Concerns (3) with 1,000 but less than 3,000 h. p.			2,205	.....	2,575	4,780
Total			169,632	.....	13,142	182,774
		SOUTH CAROLINA.				
Southern Power Co	Greenville	Saluda River	101,680	.....	73,000	174,680
	Ninety-nine Islands, Wateree	Broad River				
	Catawba, Rocky Creek, and Great Falls	Catawba River				

[1] Includes 32,000 h. p. under construction by the Yadkin River Power Co., formerly the Rockingham Power Co.

[2] See South Carolina for developed power.

[3] Of this 70,000 h. p. is being developed, but since this new development is not all expected to be completed in less than three or four years it is not included in the developed column.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		SOUTH CAROLINA—continued.	h. p.	h. p.	h. p.	h. p.
Electric Manufacturing & Power Co	Gaffney	Broad River	11,620			11,620
Courtenay Manufacturing Co	Newry	Little River		1,130	[1] 7,985	9,115
Columbia Electric Street Railway, Light & Power Co.	Columbia	Broad River	8,140			8,140
Union Manufacturing & Power Co	Neal Shoals	do		8,000		8,000
Pelzer Manufacturing Co	Pelzer	Saluda River		6,500	1,500	8,000
Anderson Water, Light & Power Co	Portman Shoals	Seneca River	7,600			7,600
Lockhart Mills	Lockhart	Broad River		2,800	4,200	7,000
Belton Power Co	10 miles east of Belton	Saluda River		5,000		5,000
Tucapau Mills	Tucapau	Middle and South Forks of Tiger River		2,700	2,000	4,700
Clifton Manufacturing Co	Clifton	Pacolet River		4,160		4,160
Ware Shoals Manufacturing Co	Ware Shoals	Saluda River		3,600		3,600
Pacolet Manufacturing Co	Pacolet	Pacolet River		3,000		3,000
Savannah River Power Co	Gregg Shoals	Savannah River	3,000			3,000
Concerns (10) with 1,000 but less than 3,000 h. p.			3,000	10,567	6,900	20,467
Total			135,040	47,457	95,585	278,082
		SOUTH DAKOTA.				
Consolidated Power & Light Co. of South Dakota	Deadwood	Cheyenne River	2,000		2,500	4,500
	Spearfish	Red Water River				
Sioux Falls Light & Power Co	Sioux Falls	Big Sioux River	3,000		667	3,667
Total			5,000		3,167	8,167

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		TENNESSEE.				
Chattanooga & Tennessee River Power Co	18 miles west of Chattanooga	Tennessee River	58,800			58,800
Wautauga Power Co	9 miles from Elizabethton	Wautauga River	3,200		3,862	7,062
Total			62,000		3,862	65,862
		UTAH.				
Telluride Power Co	Provo, Jordan Narrows, Logan, and Battle Creek.	Provo, Jordan, and Logan Rivers and Battle Creek.	23,700			23,700
Utah Light & Railway Co	4 plants	Ogden and Weber Rivers and Cottonwood Creek.	14,100		2,600	16,700
Utah-Idaho Sugar Co	Collinston	Bear River	5,600			5,600
Beaver River Power Co	Beaver County	Beaver River	4,500			4,500
Logan Municipal Plant	Logan	Logan River	3,600			3,600
Concerns (1) with 1,000 but less than 3,000 h. p.			1,200			1,200
Total			52,700		2,600	55,300
		VERMONT.				
Connecticut River Power Co. of New Hampshire.	Vernon	Connecticut River	18,000		27,000	45,000
International Paper Co	Bellows Falls and Wilder	do		[2] 19,750		19,750
	Milton	Lamoille River				
Bellows Falls Canal Co	Bellows Falls	Connecticut River	[3] 12,690			12,690
Rutland Railway, Light & Power Co	Rutland	East Branch Otter Creek	2,340		5,160	7,500
Burlington Light & Power Co	Burlington	Winooski River	3,048		4,000	7,048
Consolidated Lighting Co	Montpelier	do	6,150			6,150
Missisquoi Pulp Co	Sheldon Springs	Missisquoi River		5,000	1,000	6,000
Green Mountain Pulp Co	Middlebury	Otter Creek		1,700	3,000	4,700
Vermont Marble Co	Proctor and Center Rutland	do		4,200		4,200
Dalton Paper Mills	Fitzdale	Connecticut River		2,103	2,000	4,103
Claremont Power Co	Cavendish	Black River	2,250		1,000	3,250

[1] Power sites held by Mr. Courtenay or his company on Tugaloo, Keowee, and Little Rivers.

[2] Does not include 9,840 h. p. of water leased from Bellows Falls Canal Co.

[3] Made up of water leased to International Paper Co., 9,840 h. p.; Fall Mountain Electric Light & Power Co., 500 h. p.; 6 manufacturing companies, 2,350 h. p.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		VERMONT—continued.				
			h. p.	h. p.	h. p.	h. p.
American Woolen Co.	Winooski	Winooski River		2,844	400	3,244
Concerns (10) with 1,000 but less than 3,000 h. p.			9,170	4,600	900	14,670
Total			53,648	40,197	44,460	138,305
		VIRGINIA.				
Fredericksburg Power Co.	Fredericksburg	Rappahannock River	4,500		25,500	30,000
Virginia Railway & Power Co.	Richmond and Petersburg	James and Appomattox Rivers	16,000		3,000	19,000
Lynchburg Water Power Co.	Lynchburg	James River	4,000		7,000	11,000
Riverside & Dan River Cotton Mills (Inc.)	Danville	Dan River		9,270		9,270
Roanoke Traction & Light Co.	Roanoke	Roanoke River	3,000		2,000	5,000
Washington Mills	Fries	New River		2,500	2,500	5,000
Richmond Municipal Water Works & Municipal Electric Plant.	Richmond	James River and Kanawha Canal	3,050		1,650	4,700
Bedford Pulp & Paper Co.	do	James River		3,400		3,400
Emporia Hydro-Electric Corporation	Emporia	Meherrin River	1,800		1,200	3,000
Concerns (4) with 1,000 but less than 3,000 h. p.			1,350	2,450	1,950	5,750
Total			33,700	17,620	44,800	96,120
		WASHINGTON.				
Washington Water Power Co.	Spokane and Little Falls	Spokane River	[1] 133,000		24,000	157,000
Pacific Coast Power Co.	Electron and Snoqualmie Falls	Puyallup, Snoqualmie, and White Rivers.	[2] 77,000		53,000	130,000
Seattle Municipal Light & Power Plant	Cedar Lake	Cedar River	[3] 20,800		14,200	35,000

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Tacoma Municipal Power	La Grande	Nisqually River	[4] 32,000			
Wenatchee Valley Gas & Electric Co	Wenatchee	Entiat River and minor streams	4,730		15,000	19,730
Great Northern Ry. Co	Leavenworth	Wenatchee River	8,000		4,500	12,500
Spokane & Inland Empire R. R	Near Spokane	Spokane River	12,000			12,000
Whatcom County Railway & Light Co	Mount Baker	Nooksack River	3,300		5,000	8,300
American Power & Light Co	Naches, North Yakima, White Salmon, and Priest Rapids.	White Salmon, Columbia, and Naches Rivers.	8,080			8,080
Concerns (1) with 1,000 but less than 3,000 h. p.			1,600			1,600
Total			300,510		115,700	416,210
		WEST VIRGINIA.				
Electro-Metallurgical Co	Kanawha Falls and Glen Ferris	Kanawha River		11,750		11,750
Martinsburg Power Co	15 miles from Martinsburg	Potomac River	2,250		1,250	3,500
Winchester & Washington City Ry. Co	30 miles from Winchester	Shenandoah River	3,000			3,000
Harpers Ferry Paper Co	Harpers Ferry	Shenandoah and Potomac Rivers		[5] 4,400		4,400
Total			5,250	16,150	1,250	22,650
		WISCONSIN.				
Green Bay & Mississippi Canal Co	9 plants: Little Rapids, Combined Locks, Appleton, Little Chute, Kaukauna, Rapide de Croche.	Fox River	22,835		9,200	32,035
Chippewa Valley Railway, Light & Power Co	Eau Claire and Menomonie	Chippewa and Red Cedar Rivers	[6] 16,900		9,000	25,900
Kimberly-Clark Co	6 plants: Neenah 2, Kimberly, Niagara, and Appleton 2.	Menominee and Fox Rivers		13,450		13,450
Alexander Stewart Lumber Co. and R. L. Krause.	Wausau and Lower Grandfather Falls.	Wisconsin River		500	11,800	12,300
Chippewa Lumber & Boom Co	Chippewa Falls	Chippewa River		2,656	9,400	12,056
Lacrosse Water Power Co	Hatfield and Ross Eddy	Black River	8,000		4,000	12,000

[1] 13,000 h. p. installed; 120,000 h. p. under construction.
[2] 50,000 h. p. installed; 27,000 h. p. under construction.
[3] 4,800 h. p. installed; 16,000 h. p. under construction.
[4] Under construction.
[5] Includes 2,000 h. p. of Shenandoah Pulp Co., which has same president, treasurer, secretary, and general manager as Harpers Ferry Paper Co.
[6] Does not include 750 h. p. leased from Dells Paper & Pulp Co.

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TABLE 8.—DEVELOPED WATER POWER IN THE UNITED STATES OF CONCERNS HAVING 1,000 H. P. OR OVER (INCLUDING UNDEVELOPED POWER), CLASSIFIED BY USES, SHOWING INDIVIDUAL OWNERS OF 3,000 H. P. OR MORE—Continued.

Owner.	Location.	Stream.	Developed and under construction (wheel installation).		Undeveloped.	Total.
			Commercial.	Manufacturing.		
		WISCONSIN—continued.				
			h. p.	h. p.	h. p.	h. p.
Southern Wisconsin Power Co	Kilbourn	Wisconsin River	8,000		4,000	12,000
Nekoosa-Edwards Paper Co	Nekoosa and Port Edwards	do		[1] 10,700		10,700
Northern Hydro-Electric Co	Near Marinette	Peshtigo River	10,500			10,500
Wausau Street R. R. Co	Wausau	Wisconsin River	2,700		6,500	9,200
Bradley estate	Nigger Island, Kings, and Grandmother Falls.	do		250	8,850	9,100
Consolidated Water Power & Paper Co	Grand Rapids	do		9,000		9,000
Dells Paper & Pulp Co	Eau Claire	Chippewa River	1,000	7,529		8,529
Menominee River Boom Co	Pemene Dam	Menominee River	6,000		2,500	8,500
Menasha Woodenware Co	Near Ladysmith	Chippewa and Flambeau Rivers	2,600		5,600	8,200
Arpin Lumber Co	Bellils Falls, Bruce, and Radisson	Chippewa River		3,500	4,000	7,500
Tomahawk Paper & Pulp Co	Township 34 north, range 4 east	Wisconsin River		7,129		7,129
St. Croix Power Co	Apple River Falls	Apple River	5,600			5,600
Wisconsin River Pulp & Paper Co	Stevens Point	Wisconsin River		5,300		5,300
Marathon Paper Mills Co	Rothschild	do		[2] 5,000		5,000
Grand Rapids Pulp & Paper Co	Biron	do		4,950		4,950
Ashland Light, Power & Street Railway Co	Ashland	White River	1,800		3,000	4,800
Wausau Paper Mills Co	Brokaw	Wisconsin River		4,756		4,756
Menasha Paper Co	Ladysmith	Flambeau River		4,400		4,400
Peshtigo Lumber Co	Peshtigo and Caldron Falls	Peshtigo River		1,390	2,800	4,190
Rhinelander Paper Co	Oneida County	Wisconsin River		4,137		4,137
Merrill Railway & Lighting Co. (Kings Electric Co.).	Merrill and Lower Falls	do	3,900			3,900
Plover Paper Co	Plover and Stevens Point	do		1,900	2,000	3,900

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Centralia Pulp & Water Power Co.	Grand Rapids	do		2,800	1,000	3,800
Grandfather Falls Co.	Merrill and Grandfather Falls	do		1,816	1,800	3,616
Neenah-Menasha Water Power Co.	Menasha	Fox River		3,000		3,000
Concerns (14) with 1,000 but less than 3,000 h. p.			6,964	11,990	5,950	24,904
Total			96,799	106,153	91,400	294,352
		ALL OTHER STATES.[3]				
Concerns (9) with 1,000 but less than 3,000 h. p.			4,317	7,780	2,000	14,097

[1] Small amount for lighting.
[2] Under construction.
[3] Embracing one concern in Missouri and four concerns each in Maryland and Rhode Island.

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EXCESS DEVELOPMENT.—If the developments of less than 1,000 h. p. were included in Table 7 a comparison with figures for potential power, as shown in Table 6, page 55, would reveal a few instances in which the developed power in a State not only exceeds the estimated minimum potential power, but is approximately equal to the assumed maximum potential power. This unusual relationship of the figures in the two tables is explained by the fact that sometimes, and particularly on the smaller streams in the older States, the wheel installation exceeds even the maximum power available. A water wheel never yields its rated capacity, so that the installation is always in excess of the power actually developed. It is also true that in developments, particularly small ones, utilized for manufacturing purposes, there is sometimes an installation sufficient to utilize the high flow of a stream which occurs only a few months of the year, the power for the remaining portion of the time being supplied wholly or in part from a steam plant. Furthermore, there are occasional sites whose power has been raised above the assumed maximum by storage reservoirs. In such cases the installation is of sufficient capacity to utilize this increased volume of power. In the estimate given in Table 6, no allowance is made for storage. The above facts relating to excess development explain in part at least any apparent discrepancy between the figures for the developed and estimated potential water power.

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CHAPTER IV.

SOME PHYSICAL AND ECONOMIC PROBLEMS OF WATER POWER.

Section 1. Generation and transmission of electricity.

PRODUCTION SIMULTANEOUS WITH CONSUMPTION.—A fundamental fact in the electrical industry is that production and consumption are simultaneous. While storage batteries are increasing in practical efficiency, they are at present used only to a very limited extent, and almost wholly by the consumers of electricity rather than by the producers. They are occasionally found at central stations, but the high first cost, together with the heavy depreciation, cost of maintenance and loss of energy, have rendered such use possible only under exceptional conditions.

These facts enter vitally into the whole power problem. The equipment of a generating plant must be equal to the maximum of a widely fluctuating demand. It can not, as can other industries, store a surplus of its product in times of small demand and utilize it to meet a more than normal demand at other times. The typical power market requires power for lighting, traction, and manufacturing, and the demand for each fluctuates. Modern business is so conducted that these demands lap, and thus create what is known as the "peak of the load."[1]

Therefore, the first problem encountered in attempting to meet the demands of an industrial community is that of providing sufficient power to meet the maximum demand. If there is a comparatively slight difference between the maximum and the normal demand, the necessary excess of capacity above the average consumption will be comparatively small. The wider this difference the larger the necessary investment in equipment that must stand much of the time idle, and the higher the proportion of total investment to average output. These factors have an important practical bearing on the organization of the industry, as is shown later in more detail.

TRANSMISSION.—Under the old system of direct transmission of power a manufacturing establishment was compelled to locate at the site of power, whereas under the new conditions brought about by electrical transmission, power can be carried to the industry.

[1] So called from the appearance given to the load curve by the abrupt rise in it caused by the sudden increase of demand, which is followed shortly by an abrupt fall in the curve as the demand abates. (See chart opposite p. 86.)

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This is subject, however, to limitations prescribed by two main circumstances, namely, the cost of constructing transmission lines and the loss of energy in transmission. The economical transmission of electrical energy is, therefore, an important consideration in a water-power development.

The maximum distance over which electrical power is now transmitted is about 200 miles. This may be said to mark roughly the present economical limit of transmission. To utilize this limit the prime condition is that there must be a large amount of power available and a large demand, so that enough energy can be sold to warrant investment in long-transmission lines. The limit of electrical transmission is determined by economic rather than by physical conditions. In other words, the distance over which electrical energy can be profitably transmitted depends more upon the amount of energy available and the cost at which it can be generated and sold than it does upon the physical possibility of transmission.

Section 2. Cost of water-power development.

A fundamental, practical consideration in the development of water-power resources is the element of cost. The construction cost of a large water-power plant is very great, and its financing is usually one of the most serious questions encountered. There are many elements of uncertainty in the development of a water-power project. Estimates of the amount of power available are always subject to error and frequently exaggerated. Each development presents its own peculiar cost problems. The construction of dams and power houses must be of the most substantial sort, and in a majority of cases the cost is great. On account of unforeseen obstacles in dam construction, it is always possible that costs will exceed engineering estimates. The above are physical elements of uncertainty that must always be recognized.

Moreover, the expense at the power site is often not the largest item in the cost of hydraulic development. The large water powers of the country are generally more or less remote from power markets. It is necessary, therefore, to construct transmission lines and transformers to carry power to the point of consumption. This additional cost is often greater than that of the dam and power-house construction. The cost of transmission lines is determined by the distance from the market, and is, therefore, more properly classed as an economic element.

Furthermore, as pointed out elsewhere (p. 91), the most economical use of water power often necessitates the erection of auxiliary steam plants. Chart 4, opposite page 92, based on the actual operation of a large power system, illustrates the relative percentage of a particular power demand that is supplied by water and by steam,

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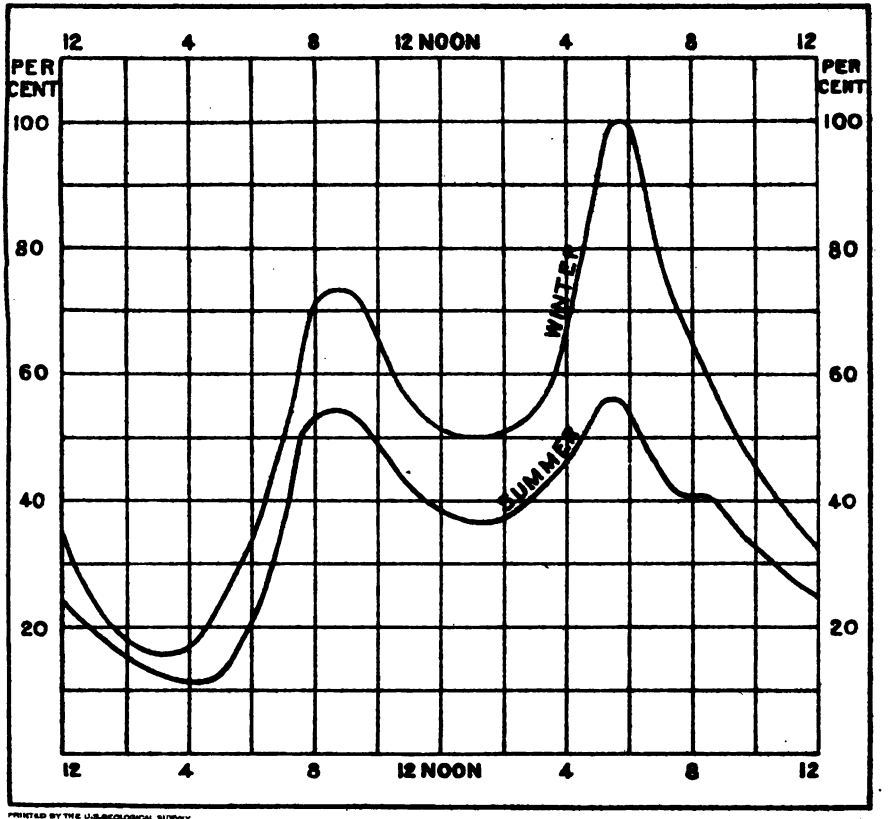
CHART 1.

LOAD CURVES INDICATING THE DAILY AND SEASONAL FLUCTUATIONS OF THE POWER DEMAND IN A TYPICAL MARKET.

(Proceedings of American Institute of Electrical Engineers, February, 1910.)



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and indicates the importance of auxiliary steam plants. While the case illustrated by the chart has an abnormally large proportion of steam installation and is, therefore, not typical, it well serves the purpose for which it is used. This system generated in one year power averaging 3,333,062 kilowatt-hours per month. The greatest quantity generated in any one month was 3,698,038 kilowatt-hours. This company has water installation of 15,000 h. p. During several months of the year, however, there was not sufficient water to develop anything like this amount of power. It was necessary, therefore, to install steam auxiliaries, with a capacity of 10,000 h. p., in order to meet the demand at all times.

The costs of installation, including the construction of dams, the erection of transmission lines and other equipment, obtained by the Bureau in the course of this investigation, ranged from about $50 to $375 per horsepower. These figures represent the extremes. Any figure representing average cost would obviously have little value. It is probable that the usual cost will fall between $100 and $200 per horsepower, depending upon physical conditions and the length of transmission lines.

Section 3. Variation in demand for power.

The typical power market has three main divisions, namely, lighting, traction, and manufacturing. If the greatest demand from each source came at a time different from that of the others, the total demand would be so distributed as greatly to reduce the required maximum capacity of the power plant. As a matter of fact, however, the demand from no one of these sources is uniform, and furthermore there is more or less overlapping of these demands. The demand for manufacturing purposes is very nearly uniform, and except for a few industries and in exceptional cases falls between 7 o'clock in the forenoon and 7 o'clock in the afternoon. Practically all the demand for lighting is at night, chiefly in the evening. The period of traction demand is longer than that for either manufacturing or lighting, and embraces practically the entire periods of both.

The period of lowest combined demand is normally between the hours of midnight and 4 o'clock in the morning. Traction demand begins in earnest about 6 o'clock and is immediately followed by the manufacturing demand. The forenoon period of active demand is from 6 o'clock to noon. In the middle of the day manufacturing establishments cease operations for an hour or less and resume again about 1 o'clock, thus restoring the demand to the level of the forenoon. Between 4 o'clock and 7 o'clock in the afternoon there is a distinct overlapping of the three demands. It is during these hours, especially in winter, that practically all the lights are turned on, manufacturing concerns have not yet stopped for the day, and

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street cars are carrying perhaps their heaviest loads. It is during this period that the highest demand of the 24 hours is reached.

There is also a seasonal fluctuation in a typical power market. The demand in winter is usually greater than in summer and the daily fluctuation is likewise greater. The increased demand grows out of the increased requirements for lighting and in some cases for traction. The greater fluctuation is mainly due to the fact that between the hours of 4 o'clock and 8 o'clock in the afternoon more power is required for light in winter than in summer.

The fluctuations of demand during the day and for winter and summer service are graphically depicted by Chart 1, opposite page 86.[1] This chart shows a typical city load curve. Charts 2 and 3, opposite pages 89 and 91, represent the demand from several localities that obtain their power from a group of "coupled-up" plants. While these charts are presented primarily to indicate the advantages of coupling up and the necessity for steam auxiliary plants, they show with equal clearness the varying load curve. The charts show so clearly the fluctuating demand for power during a day that comment is unnecessary.

The problem of power production is to meet this varying demand in the most economical way possible. The installation must be ample to meet the maximum demand, whether the generating agency is steam or water. The prime agent is only an incident. If the margin between the maximum and the general level of demand is very wide, the problem is best met by an auxiliary plant to be brought into use during the time of greatest demand. On the other hand, if the general level of the demand over the busy part of the day is but little below the maximum demand, it may be more economical not to employ an auxiliary plant. These daily and seasonal variations depend on business conditions and must be met as found.

Section 4. Natural variations in the sources of power.

Varying power demand is met with alike whether the energy is derived from steam or from water. The water-power concern, however, is confronted with a further problem. This arises from fluctuations in the supply of power due to the fluctuating flow of streams. When a steam plant is once installed a fixed production of power is assured as long as there is an available fuel supply. A steam installation, therefore, can be constructed of approximately the capacity necessary to meet the maximum demand.

A water-power installation must take into account primarily the amount of energy available. This involves the question as to how much the installation shall exceed the continuous power of the stream as measured by its minimum flow. It is apparent that if an

[1] Proceedings of the American Institute of Electrical Engineers in February, 1910.

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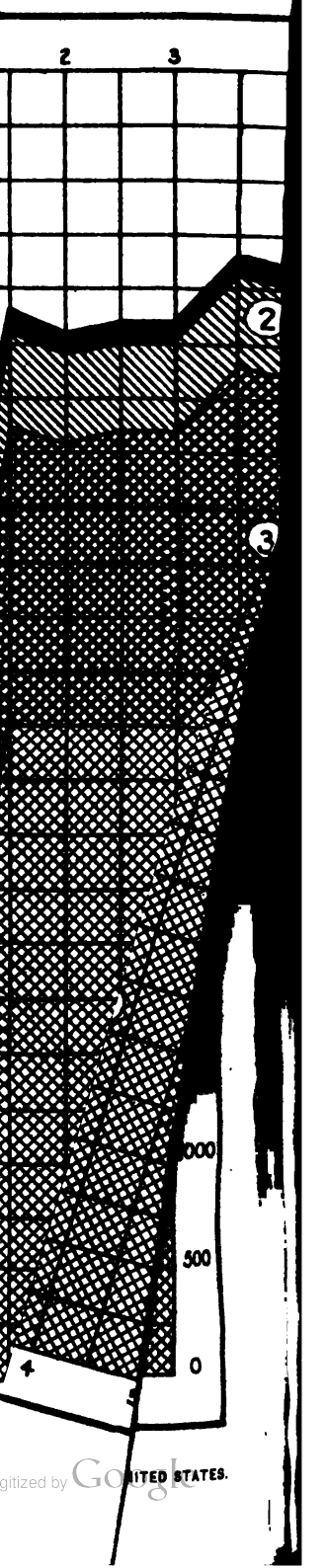

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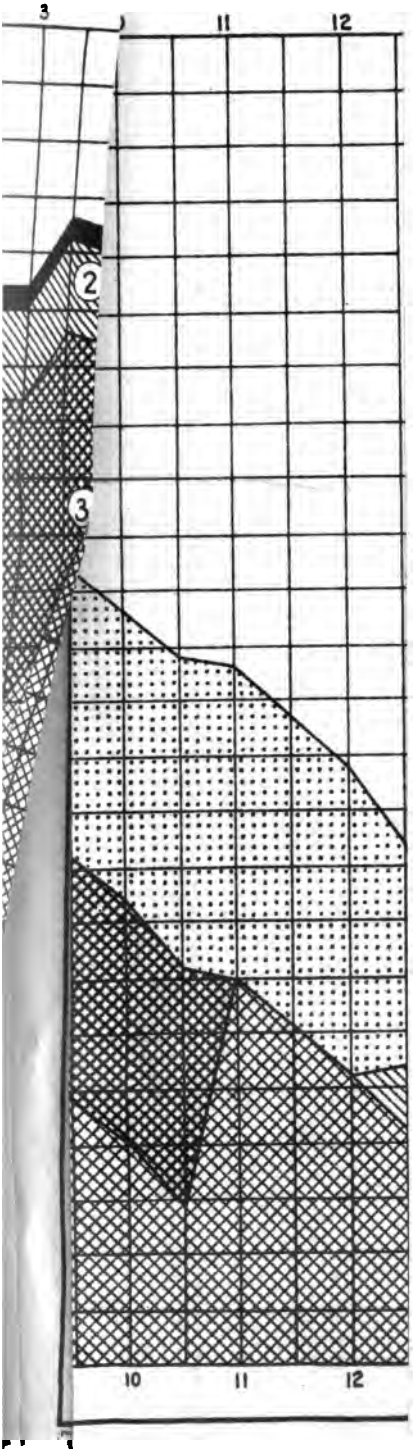

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installation is sufficient to utilize only the minimum flow of the stream there will be a tremendous loss of energy during those portions of the year in which there is a much larger flow. The calculation for installation, therefore, must take into account the possibility of utilizing more than the minimum flow.

The flow of streams varies more in some regions than in others. For example, the streams in the northeastern section of the United States are much more even in their flow than are those in the southern section. Even in the most favored regions, however, the streams fluctuate and the low periods of stream flow frequently cover several days and sometimes several weeks. There are often wide variations for different days in the same month. Furthermore, there is more or less variation from year to year. This irregularity of flow is a very important factor in any water-power development, and one that compels a reckoning with the minimum flow, together with the storage capacity, in order safely to develop an enterprise.

STORAGE.—The irregularity of the flow of streams can be partly met by storage. By the construction of reservoirs surplus water in times of high flow can be held back for use in times of lower flow. There is, however, a limit to storage and in no case can sufficient storage be maintained to give to any stream the power representing anything like its maximum flow. The practicable amount of storage depends mainly upon two factors. The first consideration is usually the topography of the locality. In some localities a practicable dam will provide storage for an immense volume of water and thus greatly enhance the minimum power of the stream. In other cases it will not. A further practical consideration is the value of land. Even with favorable topographic conditions the cost of acquiring lands to be flowed may be so great as to make any great amount of storage impracticable.

PONDAGE.—Besides the main factor of storage above alluded to, there is one of a minor nature, namely, pondage, that enters into the problem of obtaining the greatest utility from a stream. The variations in the demand for power during different periods of a 24-hour day afford an opportunity for increasing the minimum power developed from the stream. It is often the case that the average demand for power during 12 or 14 hours of the day is twice as great as the demand for the remaining 10 or 12 hours. The smaller volume of power required during a portion of the day permits an accumulation of water at the power dam itself which can be used as a reserve force to meet the higher demands during the other portions of the day. Thus, a stream that during the 24 hours might develop a continuous given horsepower would, if relieved of half of the demand for half the day, be able, with a small pondage, to supply considerably more than the average during the remaining portion of the day.

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Section 5. Economic advantage in "coupling up" two or more sites.

It is obvious from the foregoing considerations that there is a decided advantage in "coupling up" into one unit two or more sites on the same stream or sites on different streams accessible to the same markets. It may occur that of two sites tributary to a given market neither will meet the demand, whereas if both are used together they will. If, for example, there is a market for 5,000 h. p. and there are two accessible power sites, one capable of supplying 4,000 continuous h. p. and the other 1,000 h. p., it is obvious that neither alone can meet this demand; but if the two should be "coupled" together the demand can be met. This may be called making the smaller site auxiliary to the larger. It is true that the power from both sites can reach the market and can, therefore, supply it even though they are not coupled. There would, however, be the expense of separate transmission and distributing equipment and separate management, and this expense might be such as to prevent the development of the smaller power.

In the above illustration it is assumed that the power supply is continuous and can not be materially increased by pondage. As a matter of fact, the available power at a majority of sites is not continuous, and in cases conforming to actual conditions as usually found the matter of pondage is a vital one.

Again, assume two sites, one capable of meeting the demand during the hours of minimum requirements and the other large enough to meet the maximum demand extending over, say, 10 hours. If the larger plant is kept in operation constantly, its pondage will be so reduced that within 24 hours, or, at the longest, in a few days, it will not have sufficient power to meet all the demand. The smaller site can at no time meet the maximum demand. In this case neither site can separately supply the market all the time, but coupled together they can. Thus, if one site alone is able to meet the lowest demand and during this time the other plant can remain idle and accumulate water, this accumulation will contribute to meet the larger demand during the busiest period of each succeeding day. The principle is equally applicable whether the sites are on the same or on different streams, provided such sites are accessible to a common market.

Charts 2 and 2A, between pages 88 and 89, and Charts 3 and 3A, between pages 90 and 91, illustrate the practical advantage of coupling several sites. Charts 2 and 2A are based on the actual operations of a hydroelectric system that consists of four water-power developments supplemented by an auxiliary steam plant. This system serves six cities and towns (one with a population of more than 100,000) and two interurban electric railways. The system has two comparatively large water-power developments and two small ones. During the month of May (Chart 2) these hydroelectric plants

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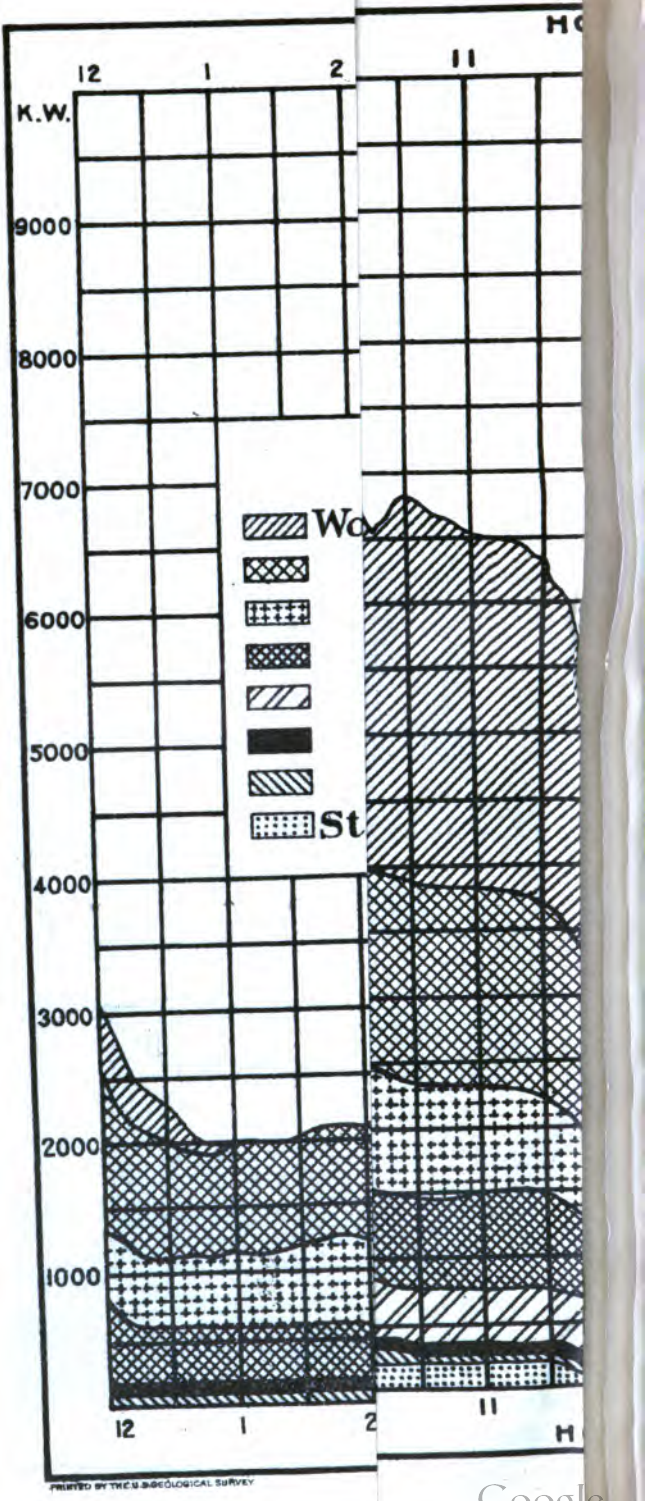

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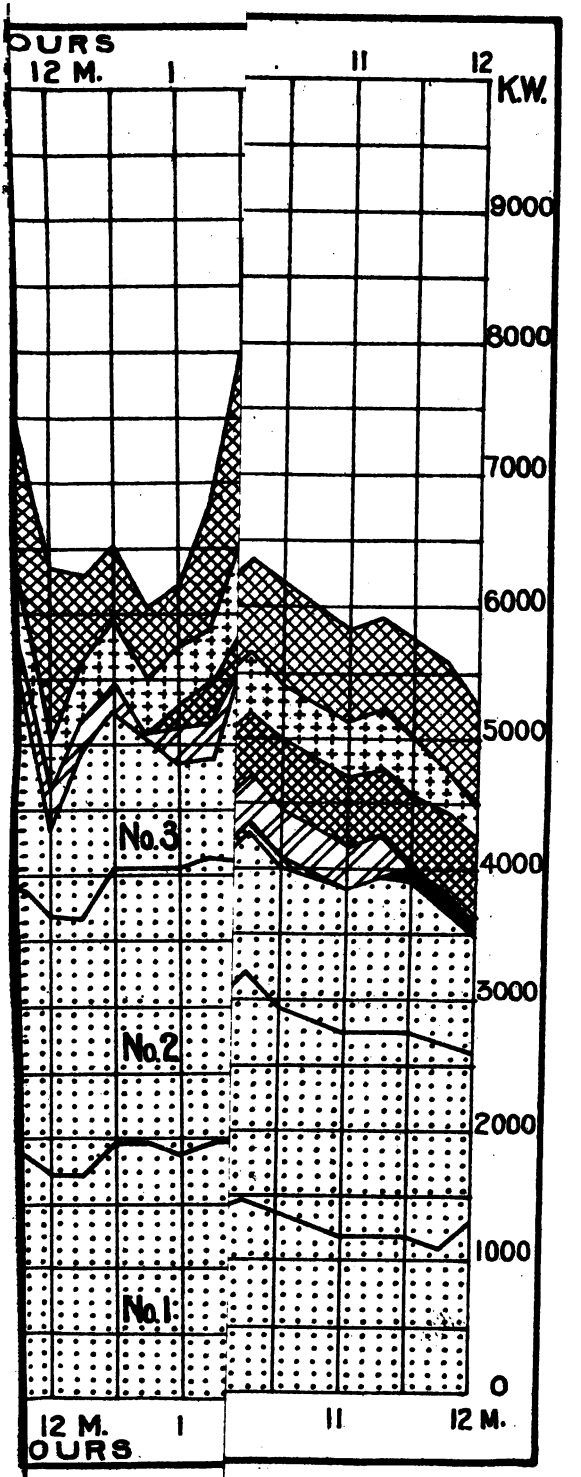

DEVELOPMENT IN THE UNITED STATES.

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met all the requirements of the power market without any assistance from the steam auxiliaries. Water-power plants 2, 3, and 4 are in this month in operation, at least in part, during the entire 24 hours, while plant 1 is in operation from 7 o'clock in the forenoon to about 6 o'clock in the afternoon, with the exception of a slight intermission about noon. Plant 4 contributes the bulk of the power during the busy hours from 7 a. m. to 7 p. m. During the remainder of the day only a portion of this plant is in operation, thus permitting the accumulation of pondage as a reserve for the busy period of the next day. This is likewise true of plants 2 and 3. Plant 3 is operated at its maximum capacity during a longer period than either of the other plants. By reference to Chart 2A, which represents the operation of this system on a day in the month of August when the water was low, it will be seen that plant 1 is in operation only for the 12 hours ending at 6 o'clock in the afternoon. Plant 2 is closed down all the time from noon to midnight, while plant 3 is practically closed all the time from 11 o'clock at night until 7 o'clock in the morning. Plant 4 is in operation during the entire 24 hours, but not at its full capacity for the entire time.

Charts 3 and 3A are based on the operations of a system that consists of seven hydroelectric developments and three auxiliary steam plants. The market for this system consists of 14 cities and towns and an extensive interurban electric railway system. In Chart 3, representing the operations of a day in May, it is seen that the water-power plants supply sufficient power to meet practically the entire demand. Plants 1, 3, 5, and 7 are in operation during only a portion of the day. In Chart 3A, which represents the operation of the same system for 24 hours at a time of low water in August, there is a much greater variation in the operation of the plants. It is particularly noticeable that plant 1, which produces the greater amount of power shown in Chart 3, is in operation but a few hours at the time represented by Chart 3A. These charts illustrate clearly the advantages of "coupling up" various sites. The significance of the steam auxiliaries shown in Charts 2A and 3A will be discussed later.

Section 6. Auxiliary steam plants.

In spite of storage, pondage, and coupling sites there is frequently a lack of steady power supply. The complete remedy for the variations in water energy and for variations in demand is found in auxiliary steam plants.

Hydraulic concerns usually provide themselves with steam auxiliaries, but sometimes make contracts by which customers supply their own needs at times of low water from their own steam plants. It is in the line of economy, however, for the hydraulic concern to operate its own steam plant. There sometimes arise emergencies when the steam auxiliary is an absolute necessity. This may occur

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in the breaking down of the hydraulic plant. It is usually good policy for water-power concerns to install sufficient steam equipment to meet the variations in supply and demand during periods of low water and also to some extent to meet any emergency that may arise.

Charts 2A and 3A, opposite pages 88 and 90, respectively, illustrate the importance of steam auxiliaries and their effectiveness in remedying the variation in the supply of water energy. These charts, as stated above, represent two power systems for a day in the month of August. Chart 2A illustrates a system with two large water-power developments and two small ones operated at a time when the water is comparatively low. By reference to Chart 2 it will be seen that in the month of May these four power sites contribute sufficient energy to meet the power demands of the markets involved. In Chart 2A, however, it is seen that the water power falls short of the demand. This lack is met by the steam auxiliary plant which at certain busy hours of the day contributes a very large proportion of the power required. Chart 3 shows the operation of a system of seven power sites in May, when they furnished practically all the power necessary to meet the market demand. Chart 3A illustrates the operations of the same seven plants shown in Chart 3 in August when the water supply was very low. Without the steam auxiliaries this power system was not able, at the later period, to meet half the demand. With the steam auxiliaries, however, the system met all the demand.

Not only the importance but the absolute necessity of steam auxiliary plants is forcibly illustrated by Chart 4, opposite this page. This chart is based upon figures representing the actual volume of power sold by the same system represented by Charts 3 and 3A. The period covered includes 12 months ended June 30, 1909. The seven hydroelectric plants operated in this system have an installed wheel capacity of approximately 15,000 h. p., and it has been found necessary to install steam turbines with an aggregate capacity of 10,000 h. p. to meet requirements when the streams are low. It should be noted in this connection that this particular system of developments has practically no storage. The lower part of the chart represents the power sold from the hydroelectric plants. It will be noticed that during the months of July, September, and October the water-power plants were not able to supply 45 per cent of the market demand, while during the months of March, April, and May they were able to supply more than 90 per cent. The upper part of the chart represents the percentage of power furnished by the steam auxiliary plants. It is apparent that but for the steam auxiliaries these water-power developments could not undertake to guarantee even half the power that is now supplied to these markets.

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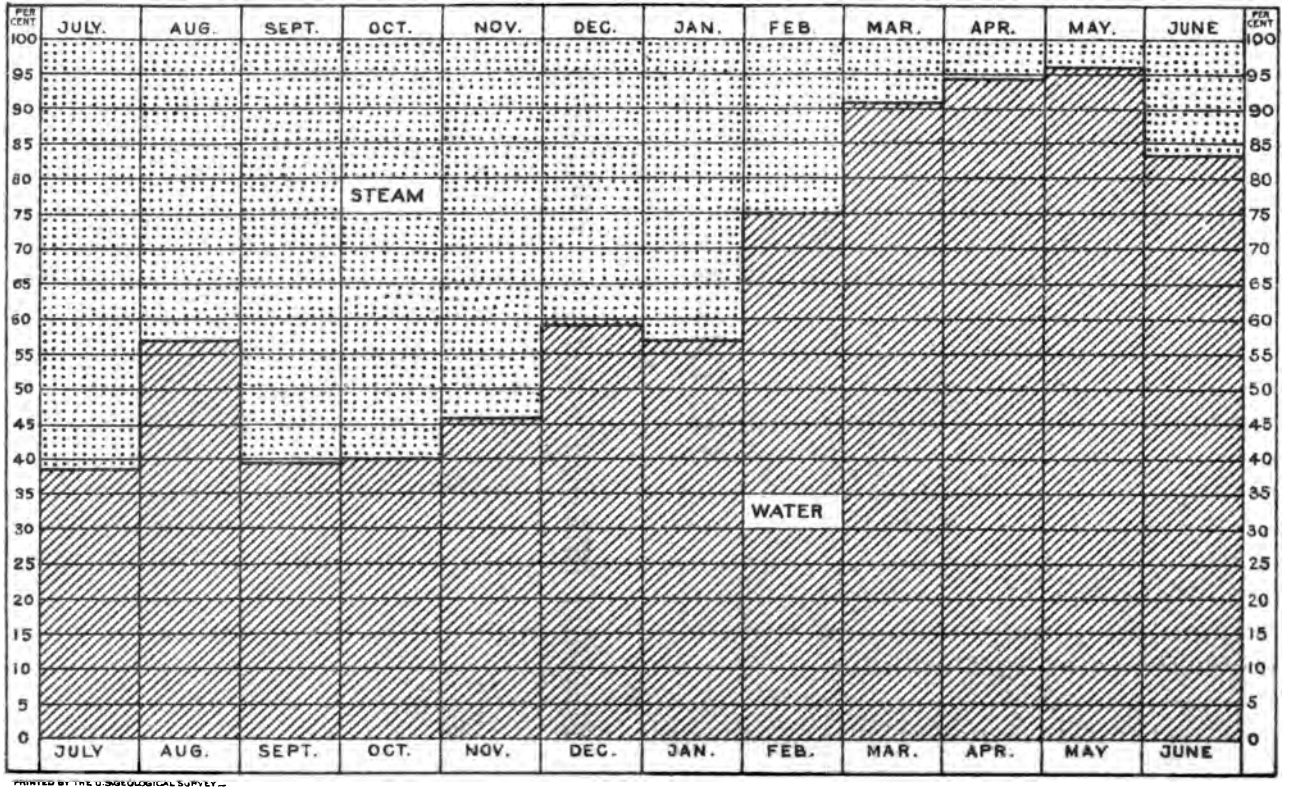
CHART 4.

PERCENTAGE OF STEAM AND WATER POWER SUPPLIED BY THE PLANTS SHOWN IN CHARTS 3 AND 3A TO A GROUP OF MARKETS, BY MONTHS.



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PART II

CONCENTRATION OF OWNERSHIP AND CONTROL

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Part II. CONCENTRATION OF OWNERSHIP AND CONTROL.

CHAPTER I.

FORCES THAT HAVE CONTRIBUTED TOWARD CONCENTRATION.

Section 1. Introductory.

There are two forms of concentration in water-power ownership; one is the ownership of practically all the commercial power in one locality, and the other is the ownership of power by the same interests in scattered localities. The former is often included in the latter. The principal concrete facts with respect to these two phases of concentration are presented in the two succeeding chapters.

Section 2. Particular circumstances that have led to concentration.

In addition to the general tendency toward concentration in the ownership of public utilities and industrial enterprises there are, in the case of water power, special forces contributing to this end. It was pointed out in a previous chapter (p. 90) that the highest efficiency and economy in the utilization of water power often requires the unifying of development. Such unification or "coupling up" of power developments results in concentration of ownership or, at least, harmony in control.

The development of large water powers usually costs more than the requirements of the average manufacturer will justify as an investment for power. Consequently only the smaller sites can generally be utilized by individual manufacturing concerns. The advance of electrical science has made it possible to use power at a distance from the point of generation, and so has greatly extended the area that may be served from a given power site. These conditions have given rise to the "commercial" development and distribution of water power in the form of electricity and have made it probable that developments at most of the larger power sites must become commercial projects. The advantages of coupling up sites and the consequent enlargement of power units greatly increase the costs of a system of developments, and in most cases an aggregation of capital is necessary.

Again, the manufacture of machinery and supplies for the generation and application of electricity is largely in the hands of a compara-

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tively few concerns. In order to expand their equipment business they have, at times, accepted the securities of hydroelectric companies in payment, at least in part, for machinery and supplies. It is probable that certain equipment companies were thus led to enter actively in the hydroelectric field. It is entirely possible that they had originally no idea of becoming interested in water power except as a means of enlarging their equipment business.

Financial houses and engineering concerns have likewise been led into the hydroelectric field through their association in financing and developing water-power properties. Water powers, if well selected, developed, and managed, are very profitable. Certain prominent equipment concerns and their subsidiaries, as well as engineering and financial concerns, have gradually become interested in the hydroelectric business as an investment. Furthermore, many officers and directors of such concerns have individually become interested in water-power developments.

Still, again, large consumers of power, such as lighting and traction companies, have, for obvious reasons, developed water-power sites as a part of their public-service systems. Conversely, hydroelectric concerns have, in other instances, acquired control of public-service corporations. This combination of hydroelectric development with public-service corporations has reached enormous proportions and is rapidly increasing. Particularly notable instances of this are discussed hereafter (p. 186). Under the various influences above mentioned, concentration of ownership and control has in the main accompanied the development of power for commercial use.

Succeeding chapters will discuss, first, typical instances of local control of water power by a single interest; second, the wide influence of large interests in individual localities and in different sections; third, the close interrelations of a few of the largest interests or groups of interests, nominally independent, that occupy powerful positions in both the hydroelectric and other public-service fields; and, finally, attention will be directed to the influence of hydroelectric concerns over public-service corporations operating in municipalities.

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CHAPTER II.

CONCENTRATION IN LOCALITIES.

Section 1. Local nature of water power.

Water power, speaking broadly, is a local resource. Within certain limits it must be utilized in the vicinity of production. The advance in methods of electrical transmission has broadened the local area of service; but even with all the advance heretofore made the area of service is still restricted to comparatively narrow limits. In only a few instances is power transmitted as far as 200 miles. Even though there should be no physical limit to transmission, the local demand and economic obstacles will usually limit the area of service. As hydroelectric development progresses in a given locality, existing industries, together with new enterprises, will develop a local demand equal to the power supply. Since in nearly all instances there is an absolutely fixed limit of water-power supply, it is easy to see that, with possibly a few exceptions, there can hardly ever be a zone of service that will much exceed present service areas.

Water-power sites are generally so grouped geographically and with relation to markets that each group is largely independent of other groups. A water power in Michigan, for instance, can not compete with one in South Carolina. Each community, or, at most, each comparatively small group of communities, stands alone, and the control in each zone of available power thus becomes an effective monopoly of a valuable natural resource. The control of all the power or the bulk of the power in a locality by one interest and the control of the bulk of the power in another locality by another interest is, in one sense, just as effective in each case as it would be if one interest controlled both. From the viewpoint of each community, moreover, local concentration is of more moment than control in several localities by a single interest. However, the sheer financial strength of a great though widespread group of local monopolies by its incidental control over electrical equipment and its relations with banking, financial, transportation, and large industial interests may add further power in each locality where it operates, or where it may desire to gain control. In its broadest aspects, therefore, the unregulated control in several localities by a single interest is a matter of great public concern.

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CONTROL IN SPECIFIC LOCALITIES.—The concentration of ownership and control of water power has steadily grown until in many communities it amounts to a practical monopoly. The area of control varies widely, according to varying local circumstances. The area of service is modified by the quantity of merchantable power, and the nature of the market. If the power site is near a great market that will readily take all its power, then the area is small; if the demand comes from two comparatively large markets a considerable distance apart, or from several widely scattered smaller markets, then the area of service is widened. On the other hand, a number of widely scattered sites may have a large common market, or a group of scattered small markets, and this affords a wide area of distribution.

The instances of local control given in the following pages do not purport to be all that exist, but they are among the most conspicuous in the classes above referred to.

Section 2. Concentration in California.

Including only the developments of 1,000 h.p. and over, California has a total of 435,467 h.p., of which 429,467 is commercial power. California is divided into four hydrographic basins, namely, (1) the San Francisco Bay Basin, which begins in the northeastern part of the State and lies between the Coast Range and Sierra Nevada Mountains, extending as far south as the headwaters of the San Joaquin River in the vicinity of Fresno and including the Sacramento and San Joaquin Valleys; (2) the North Pacific Basin, extending from the Coast Range Mountains to the Pacific coast and north from San Francisco to the State line and thence into Oregon; (3) the South Pacific Basin, which embraces a strip along the Pacific coast from the vicinity of San Francisco southward to the State line; and (4) the Great Basin, embracing that portion of the State lying east of the Sierra Nevada Mountains and including nearly all the southern part of the State. In its entirety the Great Basin includes the portion of California just described, practically all the State of Nevada, and portions of Oregon, Utah, and Idaho. Only the power in California has been included in Table 9. Besides the four basins just described, a small section of the extreme southeastern part of the State is included in the Colorado Basin.

A summary of the developed water power, grouped by basins, is presented in Table 9. In this table the main streams in the San Francisco Bay Basin and Kern River in the Great Basin are shown separately.

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TABLE 9.—DEVELOPED WATER POWER IN CALIFORNIA, BY BASINS AND STREAMS, CLASSIFIED AS COMMERCIAL OR MANUFACTURING DEVELOPMENTS.

[Compiled from data collected by this Bureau.]

Basin and stream.	Commercial.	Manufacturing.	Total.
San Francisco Bay Basin:	h. p.	h. p.	h. p.
Feather River [1]	142,593	6,000	148,593
Minor tributaries of the Sacramento	55,150	.....	55,150
San Joaquin River [2]	84,366	.....	84,366
Mokelumne River	37,500	.....	37,500
Great Basin:			
Kern River	46,310	.....	46,310
Other tributaries to Great Basin	26,618	.....	26,618
North Pacific Basin: All tributaries	13,700	.....	13,700
South Pacific Basin: All tributaries	21,830	.....	21,830
Colorado River Basin [1]	1,400	.....	1,400
Total	429,467	6,000	435,467

[1] Includes tributaries.
[2] Includes all tributaries except the Mokelumne.

The above table discloses the fact that 319,609 commercial h. p., or more than 74 per cent of the total developed commercial power in the State, is on the streams centering in San Francisco Bay; 72,928 h. p., or nearly 17 per cent of the total developed commercial power of the State, is in the Great Basin, thus placing more than 90 per cent of all the developed power of the State in these two drainage basins.

Six nominally distinct corporations, with their subsidiaries, control approximately 94 per cent of the developed power in these two basins and over 86 per cent of all the developed power in the State. These companies and their holdings of developed power appear in the following statement:

	Horsepower.
Pacific Gas & Electric Co	118,343
Great Western Power Co. (owned by the Western Power Co.)	60,000
Northern California Power Co. (Cons.)	46,900
Sierra & San Francisco Power Co.	65,500
Southern California Edison Co	38,540
Pacific Light & Power Corporation [1]	45,400
Total	374,683

The four corporations first named operate in all that portion of the State included in the Sacramento and San Joaquin Valleys; the last two, namely, the Southern California Edison Co. and the Pacific Light & Power Corporation, occupy a distinct field centering in Los

[1] The same individuals who own a majority of the stock of this company also control the San Joaquin Light & Power Corporation. The power of this concern is included with the power of the Pacific Light & Power Corporation.

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Angeles. The first four also own more than 570,000 h. p., undeveloped, and the six companies together operate steam auxiliary plants with a total capacity of about 200,000 h. p.

Particular significance attaches to the figures given in connection with the above corporations when account is taken of the fact that there is a particularly close relationship among the first three. This relationship centers in the Pacific Gas & Electric Co. An apparent relationship of the Southern California Edison Co. to the Pacific Gas & Electric Co. is established through the Great Western Power Co.

PACIFIC GAS & ELECTRIC CO. AND ITS SUBSIDIARY AND RELATED COMPANIES.—The Pacific Gas & Electric Co. was incorporated in California in 1905 as a holding company to acquire the stocks of the San Francisco Gas & Electric Co. and the California Gas & Electric Corporation. Among the corporations now controlled are the following: California Gas & Electric Corporation, San Francisco Gas & Electric Co., California Central Gas & Electric Co., Bay Counties Power Co., Valley Counties Power Co., Standard Electric Co. of California, South Yuba Water Co., Central California Electric Co., Oakland Gas, Light & Heat Co., Sacramento Electric, Gas & Railway Co., United Gas & Electric Co., Stockton Water Co., Yuba Electric Power Co., Nevada County Electric Power Co., Central Electric Railway Co., Blue Lakes Water Co.

In the organization of the Pacific Gas & Electric Co. and the controlled subsidiaries above given there were absorbed a number of other corporations, mainly electric-light and gas companies. The capital securities of the Pacific Gas & Electric Co. (1911) consist of $19,272,500 common stock, $10,000,000 six per cent cumulative preferred stock, and a bonded debt of $48,209,000, making a total capital liability of $77,481,500. The subsidiaries of this company own a number of gas and electric lighting properties, steam plants, etc., which have no water-power developments. Five of them operate hydroelectric plants. The portion of the outstanding capital liabilities chargeable to the hydroelectric concerns consists of $11,110,000 common stock, $12,075,000 in bonds, and $3,500,000 representing the proportion of general overlying bonds applicable to water-power concerns, making the total capital liability on account of water-power developments $26,685,000.

The subsidiaries of the Pacific Gas & Electric Co. have 11 hydroelectric plants, as follows: The Bay Counties Power Co. operates 3 plants on the Yuba River or its tributaries; the Valley Counties Power Co. operates 2 plants on Feather River and Butte Creek; the Sacramento Electric, Gas & Railway Co. operates 1 plant on American River; the Standard Electric Co. of California operates 1 plant on the Mokelumne River; the Central California Electric Co. operates 4 plants on the South Yuba and Bear Rivers.

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These five companies together, according to schedules furnished this Bureau, have a total developed wheel capacity rated at 118,343 h. p., as shown in the statement below:

	Horsepower.
Bay Counties Power Co.	27,260
Valley Counties Power Co.	33,500
Sacramento Electric, Gas & Railway Co.	6,250
Standard Electric Co. of California.	37,500
Central California Electric Co.	13,833
Total.	118,343

Besides the hydroelectric plants above enumerated, there are six power stations operated by steam and gas that are utilized as reserve plants and which have a rated capacity of about 90,000 h. p. The general manager of the parent company claims that they have undeveloped water power capable of economical utilization exceeding 100,000 h. p. The steam and gas power stations just mentioned are not operated by the same subsidiary companies that operate the hydroelectric plants, but since these subsidiaries are all owned by the Pacific Gas & Electric Co. they form a part of the power resources of that corporation.

In addition to the power owned by the subsidiaries of the Pacific Gas & Electric Co., as indicated in the above statement, it buys from the Great Western Power Co. 20,000 kilowatts delivered at Oakland; this is equivalent to about 26,600 electrical horsepower at Oakland.

The Northern California Power Co. (Cons.) was incorporated in 1908 and is a consolidation of the old Northern California Power Co. and its controlled companies. These controlled companies consisted of various electric light and power concerns operating in the northern part of the State. There is an evident close relationship between the Pacific Gas & Electric Co. and this company The Bank of California is its treasurer, and Frank B. Anderson, president of this bank, and Joseph S. Tobin, a director of the bank, are also directors of the Pacific Gas & Electric Co., and the latter company takes more than one-fifth (10,000 h. p.) of its power. This relationship of the Pacific Gas & Electric Co. and the Northern California Power Co. (Cons.) seems to warrant a further inclusion of 46,900 h. p. developed by the latter company but not all sold directly to the Pacific Gas & Electric Co.

The foregoing facts indicate that the Pacific Gas & Electric Co. practically controls or exerts an important influence over developed water power as follows:

	Horsepower.
Owned through subsidiaries.	118,343
Through affiliation with Northern California Power Co. (Cons.).	46,900
Purchases from Great Western Power Co.	26,600
Total.	191,843

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This power represents 60 per cent of all the commercially developed power in the San Francisco district, and nearly 45 per cent of that in the entire State.

GREAT WESTERN POWER CO.—This company was incorporated in California in September, 1906, for the purpose of developing a hydroelectric plant. It succeeded the Golden State Power Co., the Western Power Co. of California, and the Eureka Mining Co. It controls the California Electric Generating Co., which has a steam plant at Oakland. This is leased to the Great Western Power Co. The Great Western Power Co. has $27,500,000 capital stock outstanding, all of which is owned by the Western Power Co., a New Jersey corporation. All the officers of the Western Power Co. are also officers of the Great Western Power Co.

The property thus controlled consists of:

(1) Water rights and more than 34,000 acres of land at various points on the north fork of Feather River in Butte and Plumas Counties, Cal. This land includes a tract of 26,000 acres, known as Big Meadows, which is owned by the Great Western Power Co. It is of such topographical formation as to permit at comparatively small cost a storage reservoir with an area of 40 square miles and a capacity of 65,000,000,000 cubic feet of water. Work on this storage project is under way, and when completed it will greatly increase the power possibilities of the plant.

(2) A hydroelectric plant at Big Bend in Plumas County with a rated wheel capacity of 60,000 h. p. installed or being installed; in addition, it owns at least 300,000 undeveloped horsepower.

(3) A double, three-phase circuit, steel-tower transmission line 165 miles in length, delivering power from Big Bend to Sacramento, Oakland, and intermediate points.

(4) An electric steam generating plant with a rated capacity of 15,000 h. p. on the water front at Oakland.

The Great Western Power Co. has a contract to deliver 26,600 electrical horsepower to the Pacific Gas & Electric Co. at Oakland. There is thus established a substantial relationship between these two corporations. The general manager of the Great Western Power Co. is also a director in the Southern California Edison Co.

SOUTHERN CALIFORNIA EDISON CO.—The Southern California Edison Co. was incorporated in 1909 as successor to the Edison Electric Co. of Los Angeles. The latter company at the time of its organization acquired all the assets of seven corporations operating light and power plants, and in 1903 it acquired the property of eight other corporations producing power, gas, and electric light, and oper-

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ating street railways. The various water-power development companies subsidiary to the Southern California Edison Co. have seven plants, with a wheel capacity of 38,540 h. p., and auxiliary steam plants generating 16,700 h. p.

THE PACIFIC LIGHT & POWER CORPORATION.—This company was incorporated in 1902 as the Pacific Light & Power Co., to succeed the San Gabriel Electric Co., and was reincorporated under its present name in January, 1910. The Pacific Light & Power Corporation is controlled through stock ownership by the Los Angeles Railway Corporation.[1] It owns directly 24,950 h. p. Pacific Light & Power interests control the San Joaquin Light & Power Corporation, with 20,450 h. p. The Pacific Light & Power Corporation interests thus control 45,400 developed horsepower. It has steam auxiliary plants rated at 33,400 h. p. This company operates in the same general territory as the Southern California Edison Co.

SUMMARY OF EVIDENCE AS TO RELATIONSHIP OF THE PACIFIC GAS & ELECTRIC CO. TO OTHER CALIFORNIA POWER COMPANIES.—The facts above enumerated make it clear that the relationship between the Pacific Gas & Electric Co. and the Northern California Power Co. (Cons.) is close, and that there is through the purchase and sale of power an affiliation between the Pacific Gas & Electric Co. and the Western Power Co. (which owns the Great Western Power Co.). The relationship between the Great Western Power Co. and the Southern California Edison Co., operating in the southern part of the State, may not be sufficiently close to warrant the conclusion that there is a general community of interests among the four companies. It is not at present, perhaps, of special importance whether or not the northern group of corporations is closely related to either of the two companies operating in the southern part of the State. The two groups occupy entirely separate fields and each, for the present at least, has ample markets for its power. The power markets of the northern group center around San Francisco and those of the two concerns in the south center around Los Angeles.

MONOPOLISTIC POSITION OF THE PACIFIC GAS & ELECTRIC CO.—It will be recalled that the Pacific Gas & Electric Co. controls directly or influences nearly 200,000 h. p., developed and under construction, and at least 100,000 h. p. undeveloped. But as large as these holdings are, that alone does not by any means give this company a monopoly of the water power in the territory served. There is undoubtedly a vast volume of undeveloped power in this region that is not owned by it. This lack of ownership of practically all the power in the territory where it operates has not, however, prevented

[1] H. E. Huntington is sole owner of the Los Angeles Railway Corporation. (Elec. World, Nov. 24, 1910.)

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the Pacific Gas & Electric Co. from establishing a fairly effective monopolistic market condition.

The operations of this company and its subsidiaries cover the north central portion of California for about 225 miles from north to south and 125 miles from east to west. This territory embraces at least 30 counties, containing about 38,000 square miles. San Francisco, the largest city in the State, Sacramento, and other important cities are in this territory. More than two-thirds of all the people in the State are in this territory; more than 46 per cent of all the capital invested in manufacturing enterprises in the State in 1905 was in seven cities reached by its transmission lines; it owns the street railways of Sacramento and suburbs and the electric-light distributing systems in more than 40 cities and towns.

The Pacific Gas & Electric Co. serves more than 200 communities with one or more of its products; it supplies light direct to 82 of those communities. It has more than 56,000 light and power customers, besides supplying more than 12,000 street lamps.

In San Francisco, the company supplies all the lights and nearly all the power except that used by the street railways, and in fact it sells some power to the United Railroads of San Francisco. It sells power to the street railroads of Oakland; to the North Shore Railway Co.; Petaluma & Santa Rosa Railway Co.; Vallejo, Benicia & Napa Valley Railway Co.; Northern Electric Railway Co.; Sacramento Electric, Gas & Railway Co., which it owns; Stockton Railway Co.; Peninsular Railway; San Jose & Santa Clara County Railway Co.; San Jose Railway Co.; San Francisco, Oakland & San Jose Railway Co.; and Presidio & Ferries Railway Co. It owns gas plants supplying the entire city of San Francisco and at least 17 other cities and towns.

In every city or town entered by its transmission lines the company is already serving, or is in a position to serve, manufacturers with power. Since it already owns such a large number of electric-light distributing plants and gas plants in the most important cities in the territory covered, and has contracts with lighting companies or municipalities in other places, besides supplying power to 12 railway companies, just named, one of which it owns, it is readily seen that, whether or not it now owns or should hereafter acquire all the water power in this territory, its hold upon the markets is sufficient to give it a monopolistic position. Even in the future it will still occupy a very strong position for the reason that its developments and its undeveloped water powers occupy the most advantageous positions, and the developments that may be made in the future by other companies will unquestionably involve greater cost and will therefore place them at a disadvantage.

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In a letter addressed to a banking firm in May, 1909, the vice president and general manager of the Pacific Gas & Electric Co. said

> The Company serves its territory practically without competition. It owns the distributing systems in the principal centers of population, and as its service is adequate, and its rates low, there is no incentive for other companies to undergo the heavy expense of duplicating the distributing systems with a view of offering competition.

This strong foothold in the markets within the territory served by this company is probably its chief element of strength.

In its report for the year ending December 31, 1910, the company gives the following particulars as to its power and irrigation systems:

Water storage: For power, 1,173,768,000 cubic feet; for irrigation, 2,362,646,550 cubic feet; total cubic feet	3,536,414,550
Ditches and flumes: For power, 174 miles; for irrigation, 381.4 miles; total miles	555.4
Pipe lines for power, 25 in all; total length, feet	65,721
Water wheels for power, 45 in all; total capacity, horsepower	[1]117,150
Generators: 30 impulse wheel-driven, 77,132 h. p.; 8 hydroturbine-driven, 16,420 h. p.; 13 steam turbo and reciprocating, 53,349 h. p.; total 51; total capacity, horsepower	146,901
Substations on transmission lines, number, 178; capacity in transformers, horsepower	206,025
Trunk power lines operating at 60,000 volts; total miles	1,096
Distributing lines in all territories, operating under 60,000 volts, miles.	1,794
Street lights in cities and towns: Electric arcs and incandescents, 16,261; gas (Welsbach), 5,499; total number	21,760

Opposite page 106 is a map of California which shows the developed water power and transmission lines of the principal hydroelectric concerns operating in the State. This map shows that the Pacific Gas & Electric Co. occupies almost alone all that populous and prosperous region of the Sacramento and San Joaquin Valleys centering in San Francisco. The only important hydroelectric company in this section of the State that is not connected in some way with the Pacific Gas & Electric Co. is the Sierra & San Francisco Power Co. This company is controlled by the Railroads & Power Development Co., which is controlled by the United Railways Investment Co. of San Francisco. Practically all its power is used in the operation of street railways in San Francisco, and it is, therefore, not a competitor of the Pacific Gas & Electric Co. In the southern portion of the State, as will be seen from the map, are located the Southern California Edison Co. and the Pacific Light & Power Corporation, both centering in Los Angeles. The former, as already stated above,[2] has a director who is also general manager of the Great Western Power Co., which sells

[1] This figure is 1,193 h. p. less than the power given this company in the tables prepared from the schedules furnished the Bureau. The discrepancy is unimportant.

[2] See p. 102.

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a large proportion of its power to the Pacific Gas & Electric Co. Its field of operations, however, is so distinct from that of the Pacific Gas & Electric Co. that it can not be considered in any important sense as a probable competitor.

The map shows that the transmission lines of the Pacific Gas & Electric Co. do not enter any city or town that is reached by the lines of the Southern California Edison Co., or of the Pacific Light & Power Corporation. The water-power developments in the vicinity of Fresno that are controlled by the Pacific Light & Power Corporation through the San Joaquin Light & Power Corporation have a transmission line to Fresno, in which city the Pacific Gas & Electric Co. owns and operates a gas plant. At this point the Pacific Gas & Electric Co. might naturally compete with the Pacific Light & Power Corporation in the sale of power. The transmission lines of the latter company are extended north of Fresno some 35 miles, to Madera, which is approximately 50 miles from the most southerly point reached by the transmission lines of the Pacific Gas & Electric Co. at Newman.

The Sierra Pacific Electric Co. has developments on the east side of the mountains not far from the territory occupied by the Pacific Gas & Electric Co., but practically all of this power is sold in the State of Nevada. Farther south the Nevada-California Power Co., at Bishop, has considerable development, but all of this power is likewise sold in the State of Nevada and does not come into competition with any of the companies operating in California.

Section 3. Concentration in Washington.

The total developed power in the State of Washington, as shown in Table 8, page 81, is 300,510 h. p. This places Washington third in rank among the States, as to developed water power, being exceeded only by California and New York.

For convenience and clearness in this discussion the State is divided into three sections, namely, the Puget Sound region, the Spokane region, and that portion of the State drained by the Columbia River and its tributaries, not including the Spokane River. The developed water power in each of these three regions is shown in the following statement:

	Commercial horsepower.
Puget Sound region	134,700
Spokane region: Spokane River	145,000
Columbia River region: Tributaries other than Spokane River	20,810
Total	300,510

From the foregoing statement it may be seen that of the power developed and under construction in the State, 134,700 h. p., or

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almost 45 per cent of the total of such power in the State, is in the Puget Sound region; 145,000 h. p., or approximately 48 per cent, is in the Spokane region, and the remainder, about 7 per cent, is in the Columbia River region.

Opposite page 112 is a map showing the developed water power in Washington and the territory covered by the transmission lines of each power owner. It will be seen from this map that the vicinities of Seattle and Tacoma, Spokane, and Walla Walla are the only sections of the State having any considerable service from developed water power.

PUGET SOUND REGION.—This region embraces that portion of the State west of the Cascade Mountains and includes Seattle and Tacoma, two of the largest cities in the State, besides other important towns. The greatest industrial development of the State is in this region. The total water power, developed and under construction, in this section, as previously shown, is 134,700 h. p. The ownership or control of this power is shown in the following statement:

	Horsepower.
Pacific Coast Power Co.	77,000
City of Tacoma	32,000
City of Seattle	20,800
Whatcom County Railway & Light Co.	3,300
Olympia Light & Power Co.	1,600
Total	134,700

Besides the above power, developed and under construction, the Pacific Coast Power Co. and the City of Seattle, respectively, own 53,000 h. p. and 14,200 h. p., undeveloped. A striking fact brought out by the above statement is the ownership of 52,800 h. p., developed and being developed, by the cities of Seattle and Tacoma. This is more than 39 per cent of the total power, developed and under construction, in this region. The details of city-owned power are discussed elsewhere. (See p. 196.)

Pacific Coast Power Co.—By far the most important owner of developed power in the Puget Sound region is the Pacific Coast Power Co., with 77,000 h. p., or 57 per cent of all the power, developed and under construction, in this section of the State. This company is under the management of Stone & Webster Management Association,[1] which also manages the Whatcom County Railway & Light Co. These two companies have the same president and practically the same officers throughout. The Whatcom County Railway & Light Co. has 3,300 h. p., developed, and in this discussion this power is included with that of the Pacific Coast Power Co.

The Pacific Coast Power Co. controls 27,000 h. p. direct; 20,000 h. p. through the Puget Sound Power Co., a subsidiary; 30,000 h. p.

[1] For details of the properties managed by the Stone & Webster Management Association, see sec. 3, p. 163.

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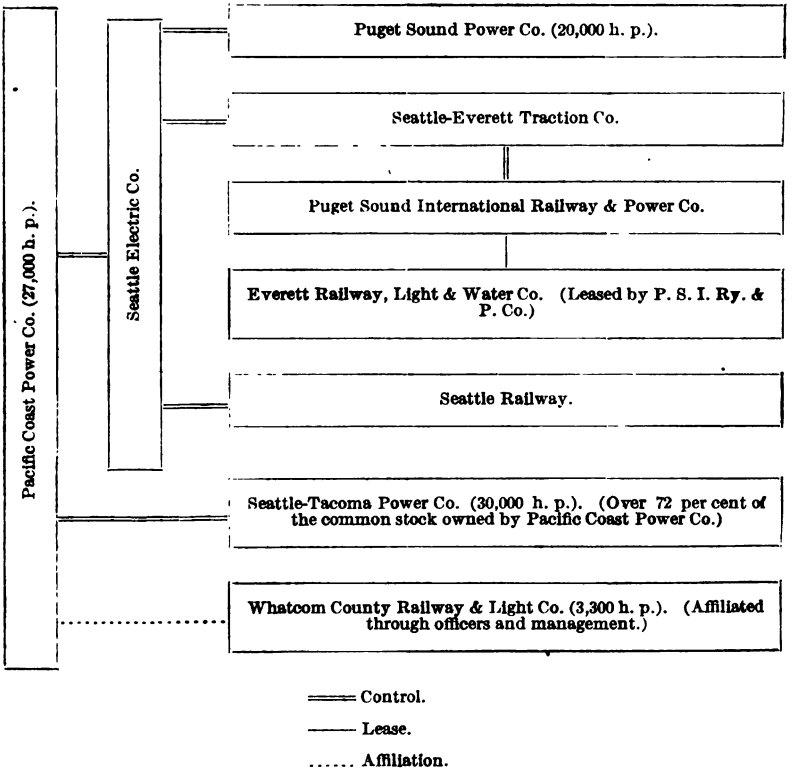
through the Seattle-Tacoma Power Co., more than 72 per cent of whose common stock it owns; and 3,300 h. p. through the Whatcom County Railway & Light Co. There is thus embraced in this single management and practically the same ownership 80,300 h. p., or 60 per cent of all the power, developed and under construction, in this region.

The Pacific Coast Power Co. controls most of its subsidiary corporations through the Seattle Electric Co.; the Seattle Electric Co. controls the Puget Sound Power Co., the Seattle-Everett Traction Co., and the Seattle Railway. The Seattle-Everett Traction Co. controls the Puget Sound International Railway & Power Co., which leases the Everett Railway, Light & Water Co. This corporate relationship is shown graphically below.

CORPORATIONS CONTROLLED BY OR AFFILIATED WITH THE PACIFIC COAST POWER CO.


Pacific Coast Power Co. (27,000 h. p.).
Seattle Electric Co.
Puget Sound Power Co. (20,000 h. p.).
Seattle-Everett Traction Co.
Puget Sound International Railway & Power Co.
Everett Railway, Light & Water Co. (Leased by P. S. I. Ry. & P. Co.)
Seattle Railway.
Seattle-Tacoma Power Co. (30,000 h. p.). (Over 72 per cent of the common stock owned by Pacific Coast Power Co.)
Whatcom County Railway & Light Co. (3,300 h. p.). (Affiliated through officers and management.)
Control.
Lease.
Affiliation.

The position of the Pacific Coast Power Co. is probably not as strong as that of some other water-power companies similarly situated. This is due to the fact that the two principal cities in this region own large water powers that are being developed for public use. Its position, however, is very strong. It controls 80,300 h. p.,

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developed and under construction, and 58,000 h. p., undeveloped, and it also controls many of the municipal public-service corporations in the cities and towns reached by its transmission lines.

The Puget Sound Power Co. generates power for distribution in Seattle and Tacoma and intermediate points. It sells power to the Pacific Coast Power Co., the Seattle Electric Co., and the Puget Sound Electric Railway and lights the town of Orting, Wash.

The companies controlled by the Pacific Coast Power Co. do the street railway business of Seattle, Everett, and Lowell; they have interurban electric railway lines connecting Seattle, Ballard, and West Seattle; they own and operate a line from Seattle to Everett, a distance of more than 30 miles, and they operate a line from Everett to Snohomish.

They supply electric light to Ballard, Everett, Lowell, and Marysville, and do a greater portion of the commercial lighting business in Seattle.

The Seattle-Tacoma Power Co., which is controlled by the Pacific Coast Power Co., does a general lighting and power business in Tacoma, Seattle, Everett, and other smaller towns. The Whatcom County Railway & Light Co. does the entire electric railway, light, and power business of Bellingham.

The market position of the Pacific Coast Power Co., through its directly controlled and affiliated corporations, is very strong, notwithstanding the fact that two of the principal cities are constructing hydroelectric plants for the purpose of supplying light to the municipalities. The industrial development already made and being made in this region, is sufficient to furnish a market for all the water power that is now developed, and probably much more. This strong market position is made still stronger, however, by virtue of the fact that the Stone & Webster management of these power companies and their subsidiary and affiliated public-service corporations also extends its influence to other public-service corporations in this territory that have no water power. For example, the Stone & Webster Management Association manages the Puget Sound Electric Railway, which controls the Tacoma Railway & Power Co. These two companies do the entire electric railway and a portion of the electric power business of Tacoma. The Pacific Traction Co., another subsidiary of the Puget Sound Electric Railway, owns an electric railroad between Tacoma and American Lake, with branches to South Tacoma and to the State Asylum for the Insane. The Pacific Traction Co. buys its power from the Seattle-Tacoma Power Co. There is thus placed under single control, directly and indirectly, through the Stone & Webster Management Association, practically all the public utilities in the principal cities of the Puget Sound region. This strong market

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position of the Pacific Coast Power Co., together with its already large developed water powers, gives it an enormous advantage over any possible future competitor.

SPOKANE REGION.—All the water power, developed and under construction, in the vicinity of Spokane is owned by two companies which, together, have 145,000 h. p., developed. The map opposite page 112 shows the power sites and transmission lines of these companies. The ownership of the power, developed and under construction, in this region is as follows:

	Horsepower.
Washington Water Power Co.	133,000
Spokane & Inland Empire Railroad	12,000

The Washington Water Power Co. also owns 18,000 h. p., developed, at Post Falls, Idaho, and it has 24,000 h. p., undeveloped, on the Spokane River in Washington.

Washington Water Power Co.—This company has four power sites, developed and under construction, namely, three in Washington, with 133,000 h. p., and one in Idaho, 20 miles east of Spokane, with 18,000 h. p., or a total of 151,000 h. p. One of its developments, rated at 13,000 h. p., is within the city limits of Spokane. It also has a steam plant in Spokane, with a capacity of 19,000 h. p.

The company owns and operates most of the street railways of Spokane, besides interurban lines which, together, have more than 100 miles of track. The company furnishes all the electric current for lighting and power in Spokane. It has more than 530 miles of long-distance transmission lines and furnishes light and power in the Coeur d'Alene mining district and also in the Palouse, Pend d'Oreille, and Big Bend districts, all in Idaho. Transmission lines are projected for about 100 miles west of Spokane, and an equal distance east and south of that city.

Spokane & Inland Empire Railroad.—This is a holding and operating company and owns all the stock of the Spokane Traction Co., the Coeur d'Alene & Spokane Railway Co. (Ltd.), the Spokane Terminal Co., the Spokane & Inland Railway Co., and the Spokane Power Development Co. Its developed water power consists of 12,000 h. p., at a site on the Spokane River, 13 miles below the city of Spokane.

The Spokane & Inland Empire Railroad operates an interurban railway from Spokane to Coeur d'Alene and Hayden Lake, Idaho, and one from Spokane to Spring Valley Junction, where the line divides, with one branch running to Colfax, Wash., and the other to Moscow, Idaho. The company operates 45 miles of track in the city of Spokane, which, with the interurban lines above named, gives it a total trackage of more than 214 miles of main line. It has a municipal lighting franchise in Spokane.

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The Spokane & Inland Empire Railroad does a general railroad business. It carries passengers, freight, and mail and makes connections with the Great Northern and other railroads entering its territory. The electric power generated by the company is not sufficient to operate all its trains and it employs six steam locomotives.

While the Washington Water Power Co. and the Spokane & Inland Empire Railroad operate in the same territory, there does not appear to be any considerable conflict of interest. The former company, as appears from the above, seems to be primarily engaged in the operation of street-railway systems and the selling of light and power. The Spokane & Inland Empire Railroad apparently uses most, if not all, of its power in the operation of its railroad lines.

COLUMBIA RIVER REGION.—Outside of the development in the vicinity of Spokane there is only 20,810 h. p. developed on the Columbia River and its tributaries. This power is owned by the Great Northern Railway, the American Power & Light Co., and Wenatchee Valley Gas & Electric Co., with 8,000 h. p., 8,080 h. p., and 4,730 h. p., respectively.

The Great Northern Railway development is in the vicinity of Leavenworth, with a transmission line to the vicinity of Wellington.

The American Power & Light Co.—The American Power & Light Co. was organized in 1909 as a holding company to acquire light, heat, and power companies in the western part of the United States. It was organized by the Electric Bond & Share Co. (a General Electric subsidiary) and is controlled by interests identified with that company. At the time of its organization it acquired a controlling interest in the Edison Light & Power Co., and the Gas & Electric Appliance Co. of Wichita, Kans. It acquired also the Home Light, Heat & Power Co. of Frontenac and Pittsburg, Kans. These Kansas companies have since been consolidated into the Kansas Gas & Electric Co. At the same time the American Power & Light Co. acquired the stock of the Astoria Electric Co. of Astoria, Oreg., and all the common stock of the Portland Gas & Coke Co., the latter company controlling the Portland Gas Co., of Portland, Oreg.

The American Power & Light Co. controls the Pacific Power & Light Co., through stock ownership. The latter company was incorporated in 1910, and took over the gas properties in Walla Walla and North Yakima, Wash.; Lewiston, Idaho; and Astoria and Pendleton, Oreg. It also took over the holdings of the Northwestern Corporation of Philadelphia and the power and lighting system formerly owned by the Wasco Warehouse & Milling Co., and thus acquired a water-power generating plant on the White River, in Oregon, and one on the Naches River and another on the Walla Walla River, in Washington. It later acquired the properties of the Hanford Irrigation & Power Co. in Washington.

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The developed water power of the American Power & Light Co. (owned through the control of the Pacific Power & Light Co.) consists of four developments of 7,760 h. p. in Oregon and three in Washington of 8,080 h. p., or a total of 15,840 h. p. The locations of the power sites and transmission lines in Washington are shown on the map.

In Washington this company, through subsidiaries, operates gas plants at Walla Walla and North Yakima, and the street railways in Walla Walla and an interurban railroad from Walla Walla, Wash., to Milton, Oreg. Altogether it has 30 miles of main track. The company also owns and operates waterworks in North Yakima and at Kennewick and Pasco.

The American Power & Light Co. is closely affiliated with the Washington Water Power Co. As already stated, the American Power & Light Co. is controlled by the General Electric interests through the Electric Bond & Share Co. There is still further affiliation between these two companies by virtue of a contract for the interchange of power. Under this contract the surplus power generated by either of these companies can be taken by the other. It is expected that the amount of power which may thus ultimately be interchanged will not be less than 8,000 h. p. The contract provides for the construction of a transmission line between Pasco and Lind, which will connect the system of the American Power & Light Co. with that of the Washington Water Power Co. By reference to the map of Washington, opposite this page, it will be seen that the connection of the transmission lines of these companies will place them in a very strong position in all that region embracing the Yakima Valley and northeastwardly to Spokane.

Section 4. Concentration in Montana.

In Montana there is 139,260 h. p., developed or being developed. Montana ranks fifth among the States in commercial water power developed and under construction.

Practically all the water power developed and under construction in Montana is controlled by two companies, namely, the Butte Electric & Power Co. and the United Missouri River Power Co., with 69,260 h. p. and 65,000 h. p. respectively. The location of the power sites and the transmission lines of these companies is shown on the map opposite page 114.

Butte Electric & Power Co.—This company was incorporated in New Jersey in 1901. Its outstanding capital liabilities consist of $1,000,000 preferred stock, $4,000,000 common, and about $5,000,000 bonds. It controls the Madison River Power Co.; Billings & Eastern Montana Power Co.; Montana Power Transmission Co.; Phoenix Electric Co.; Livingston Water Power Co.; Gallatin Light, Power

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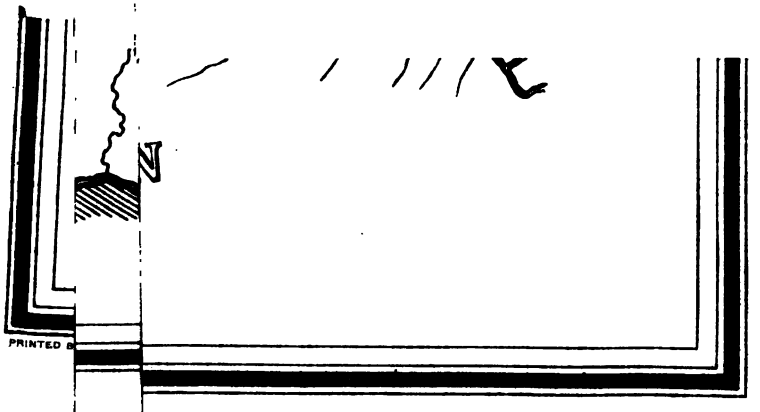

CORPORATIONS ON WATER-POWER DEVELOPMENT IN THE UNITED STATES.

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& Railway Co.; and Butte Gas Light & Fuel Co.; and it owns half the stock of the Great Falls Water Power & Townsite Co.[1] The Butte Electric Co. and its constituent companies have water power, developed and under construction, to the amount of 24,900 h. p., and the Great Falls Water Power & Townsite Co. has 44,360 h. p., thus placing under Butte Electric control 69,260 h. p. A detailed statement of the water power, developed and under construction, thus controlled, follows:

	Horsepower.
Great Falls Water Power & Townsite Co., at Great Falls	44,360
Madison River Power Co., at Madison Canyon	15,000
Montana Power Transmission Co., at Big Hole	4,000
Billings & Eastern Montana Power Co., at Billings	2,000
Livingston Water Power Co., at Livingston	2,000
Great Falls Electric & Street Railway, at Great Falls	1,000
Development near Whitehall	900
Total	69,260

Besides the power developed and under construction these companies own undeveloped water power estimated at 97,600 h. p. They also have steam plants with an aggregate capacity of 4,400 h. p. The Butte Electric & Power Co. is not only the largest owner (including the Great Falls power) of water power in the State, but it has a foothold in the best markets in the State and actually owns a number of the electric distributing plants and other public-service corporations. It carries on a gas, electric-light, and steam-heating business in Butte, and distributes electric light in the suburbs of that city; it owns the street-railway and the electric-light distributing system throughout Great Falls and suburbs; it also owns the electric-light distributing systems of Bozeman, Billings, and Livingston, and 17 miles of interurban electric railway connecting Bozeman with the State Agricultural College.

THE UNITED MISSOURI RIVER POWER CO.—This company has water power developed and under construction to the amount of 65,000 h. p., including the properties of the Helena Power Transmission Co., at Hauser Lake; the Missouri River Power Co., at Kenyon; and the Capital City Power Co., at Holter. It has a steam plant at Butte, with a capacity of 6,000 h. p. The operations of this company extend particularly into the mining and smelting districts; it transmits power to Anaconda, Helena, Butte, and several other towns and mining camps; and it rents power through the Missouri River Power Co. to the Helena Light & Railway Co., which does the entire street-railway, electric-light, and gas business of Helena.

MONOPOLISTIC POSITION OF THE BUTTE ELECTRIC & POWER CO. AND THE UNITED MISSOURI RIVER POWER CO.—These two companies

[1] This company was very recently separated into two corporations; one of them, the Great Falls Power Co., took over the water power, and the other took the townsite property.

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together dominate the power situation in Montana. It will be seen from the map of Montana that the transmission lines of these two companies, extending from Butte, are parallel and very close together. It is noticeable, however, that the transmission line of the Butte Electric Co. does not enter the city of Helena at all. In Butte, the Butte Electric does an electric-light and steam-heating business, while the United Missouri River Power Co. appears to have the power business among the mines in that vicinity.

These two companies, as will be seen from the map, operate in the industrial centers of the State and, speaking generally, in the most populous counties. Ten counties embraced either in the operations of these companies or within easy reach of them contain about 45 per cent of the total population of the State.

While there is an abundance of undeveloped water power within transmission distance of the territory covered by these two companies, independent development would be at a disadvantage because the markets for power are now in control of the Butte Electric and United Missouri River companies. The Butte Electric now has an unbroken chain of transmission lines from Great Falls southerly to Butte and Anaconda, and thence easterly to Billings, a total distance of about 350 miles.

Section 5. Concentration in Colorado.

Table 8, page 67, gives the total power developed and under construction in Colorado as 69,690 h. p. The developed commercial power by streams is shown in the following statement; there are no manufacturing developments of 1,000 h. p. or more.

	Commercial horsepower.
Arkansas River, including tributaries	4,840
San Juan River, including tributaries	8,000
Grand River, including tributaries	34,050
South Platte River, including tributaries	22,800
Total	69,690

The above table shows that 56,850 h. p., or about 80 per cent of all the power developed and under construction in the State, is on the Grand and South Platte Rivers, or their tributaries. Table 8, page 67, shows that 39,000 h. p. of the developed power on these streams is owned by the Central Colorado Power Co. This company practically dominates the power situation in the State.

CENTRAL COLORADO POWER CO.—This company was incorporated in Colorado in 1906. On December 31, 1910, its capital liabilities amounted to $34,306,950, consisting of $15,000,000 common stock, $7,500,000 preferred stock, and $11,806,950 in bonds. It owns all the stock of Leadville Light & Power Co., and it has a very advantageous contract with the United Hydro-Electric Co., which is dis-

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cussed hereafter. The San Juan Water & Power Co. is also practically under its control through common officers and directors.

Water-power properties.—The water-power properties of the Central Colorado Power Co. consist of 39,000 h. p. developed and under construction, and 50,000 undeveloped. This developed power is all on the Grand River, and on Boulder Creek, a tributary of the South Platte. The developed power on each of these streams and the percentage of it owned by the Central Colorado Power Co. is shown in the following statement:

	Total horsepower.	Owned by Central Colorado Power Co.	Per cent.
Grand River	34,050	18,000	53
South Platte River	22,800	21,000	92
Total	56,850	39,000	69

From this statement it is seen that all the power developed and under construction on the South Platte River, except 1,800 h. p., is owned by the Central Colorado. This 1,800 h. p. is owned by the United Hydro-Electric Co., which is an ally. Of the 16,050 h. p. developed and under construction on the Grand River and owned by others than the Central Colorado Power Co., 9,450 h. p. is owned by the Telluride Power Co., in the southwestern part of the State; 5,000 h. p. is being developed by the Commonwealth Power & Electric Co., near Kremmling; and 1,600 h. p. is owned by the Summit County Power Co., at Dillon. A map opposite page 116 shows the water powers in Colorado, developed and under construction, and the territory covered by transmission lines.

From this map it will be seen that the operations of the Central Colorado Power Co. cover the central portion of the State; the other owners of power in this region, that have been enumerated above, can scarcely be considered competitors. The United Hydro-Electric Co. has only 1,800 h. p. developed. It has distributing lines in the vicinity of Georgetown, Idaho Springs, and Central City, and reaches the important mining camps in Clear Creek and Gilpin Counties. The United company is under contract to take all the additional power required by it from the Central Colorado, and to push the sale of power in its territory. In speaking of the advantages of this contract in 1908 the general manager of the Central Colorado Power Co. said:

> This arrangement not only secures this company an important power customer, but relieves it of the large investment for substations and a distributing system in the territory now occupied by the United company. It also gives to this company the benefit of the active cooperation of very capable men, fully acquainted with all the local conditions.

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The United Hydro-Electric Co. is thus not a competitor, but a valuable ally.

The Commonwealth Power & Electric Co., which is developing a site near Kremmling, is in Central Colorado territory and very near a large undeveloped site of that concern. It is not yet a competitor of the Central Colorado Power Co. and there is no evidence in possession of this Bureau that it will be.

The Summit County Power Co. has only 1,600 h. p. and is too small to be taken into account as a competitor. The Telluride Power Co.[1] operates in a separate and considerably distant portion of the State, and is not a competitor. The San Juan Water & Power Co. is very closely affiliated with, if not entirely controlled by, the same interests that control the Central Colorado Power Co.; S. Z. Mitchell is vice president of the Central Colorado Power Co. and a director in the San Juan, and J. R. McKee is a director in both companies. The only other developments in the State are in the vicinity of Colorado Springs and Cripple Creek. The Colorado Springs Light, Heat & Power Co. has 3,000 h. p. developed at Pikes Peak, and transmits power to Colorado Springs, where it operates all the lighting companies. The Pueblo & Suburban Traction & Lighting Co. has a 1,840 h. p. development near Victor, where power is supplied to Cripple Creek, and where it operates a lighting plant. It controls the street-railway and lighting business of Pueblo. These two companies are outside the present operating territory of the Central Colorado Power Co.

This ownership of developed water power does not fully measure the power resources of the Central Colorado Power Co. It has at least 50,000 h. p. of undeveloped water power. In describing the strong position of the company as an owner of water power, the general manager in 1908 said:

> A large quantity of hydrographic and other data has been collected by the engineering department and tabulated and analyzed, and this work will be carried on actively in the future. This information will be of the greatest value to the Company, not only in affording data as to the water-powers owned by the Company, *but as indicating what additional water powers are available when occasion arises for increasing the generating capacity, and what it might be possible for others to do with such other water powers in competition with this Company.*[2] The Company already owns water powers in addition to those above referred to,[3] and has options on others which may prove of value in the future.

This Bureau has no exact information as to the options alluded to in the above excerpt. Evidently the general manager of the company regards it as dominating the water-power situation in the State.

[1] For a description of all the operations of the Telluride Power Co., see p. 173.

[2] Italics by Bureau.

[3] This probably refers to the 50,000 h. p. undeveloped that has been referred to in the previous discussion.

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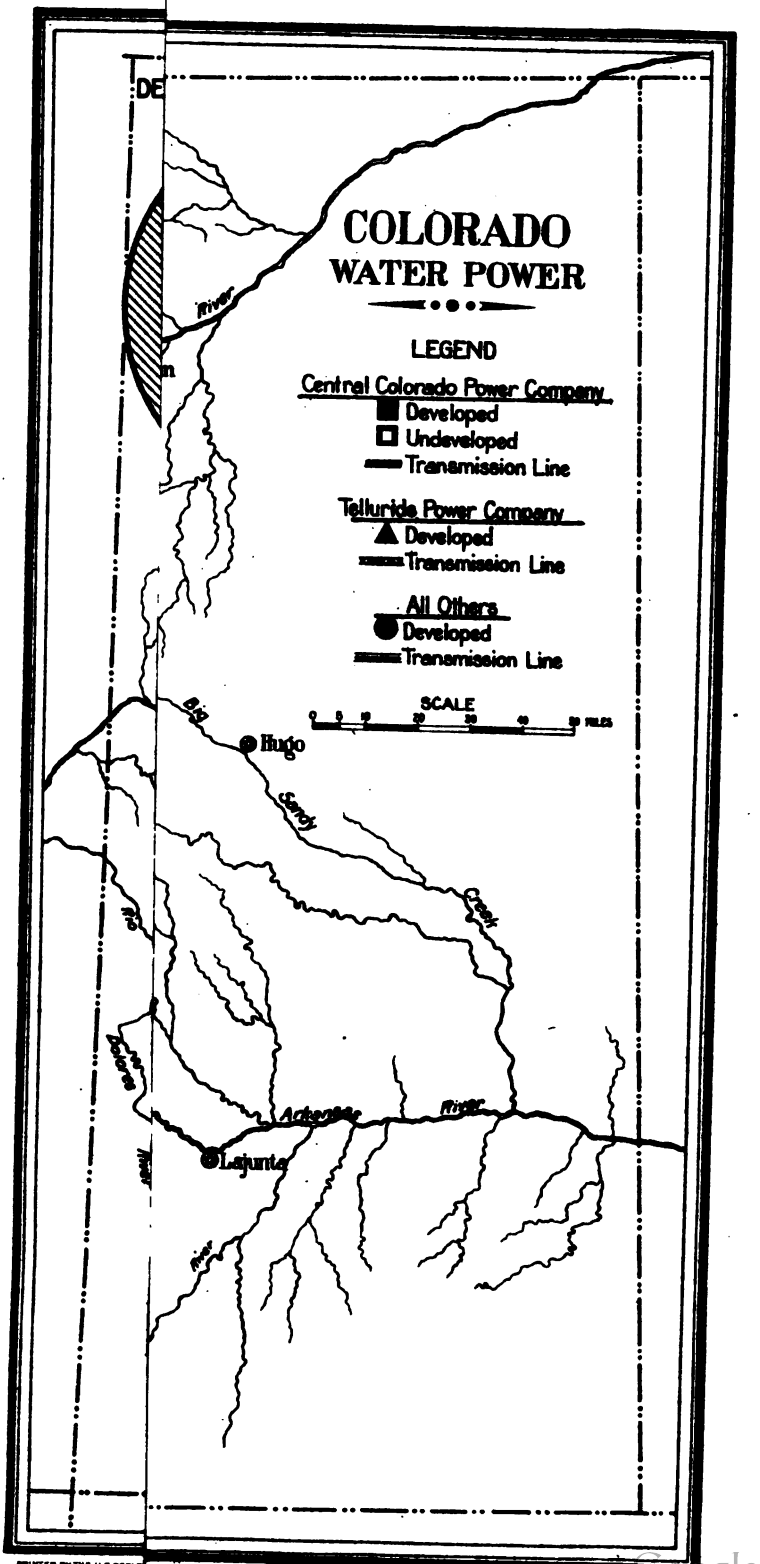

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RPORATIONS ON WATER-POWER DEVELOPMENT IN THE UNITED STATES.

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Market position of the Central Colorado Power Co.—As strong as is the position of this company, as indicated by its ownership of power and its strategic location, its dominant position is vastly strengthened by virtue of the markets reached by it. The map shows that the present transmission lines of this company extend from the development near Glenwood Springs to Denver, where another transmission line comes from their development on Boulder Creek. As already stated, it has a contract to supply power to the United Hydro-Electric Co., which company supplies all the power in Georgetown, Idaho Springs, Central City, and vicinity. The Denver Gas & Electric Co., which operates a lighting plant in the city of Denver, purchases a large volume of power from the Central Colorado Power Co.; and the Northern Colorado Power Co., which has a steam plant of 12,000 h. p. capacity at Lafayette, also purchases power from the Central Colorado. This company thus has for its customers the principal light and power distributing concerns in the territory reached by its lines. Its present developments, together with its undeveloped sites, are within economical transmission distance of Pueblo, and numerous other prosperous communities. The possible area of service, therefore, of the Central Colorado Power Co. includes all the central portion of the State, where are found all the largest cities with their industrial enterprises. The territory reached by or easily accessible to this company includes about 65 to 70 per cent of all the population of the State.

This strong position of the Central Colorado Power Co., as indicated by its ownership or control of water power and by its hold upon the principal markets of the State, together with the absence of any practical competition, places it practically in a monopolistic position. The fact that this company does not own nearly all of the available water power in the State or even in the territory where it operates, does not indicate a lack of control.

Section 6. Concentration in North Carolina and South Carolina.

The total water power, in ownerships of 1,000 h. p. and over, developed and under construction, in all the States lying south of the Ohio River and east of the Mississippi, is, in round figures, 575,000 h. p., of which 457,000 is here classed as "commercial" power and 118,000 as power developed and used by manufacturers. The relation of the commercial power in North Carolina and South Carolina to the total commercial power, above described, may be summarized as follows:

	Commercial power.	Per cent of total.
Total commercial power (plants of 1,000 h. p. and over), developed and under construction, in States south of the Ohio and east of the Mississippi Rivers....	*h. p.* 456,877	.....
In North Carolina.....	82,960	18
In South Carolina.....	135,040	30
In the two States.....	218,000	48

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According to the Bureau of the Census (1908), these two States have about 136,000 h. p. in developments of less than 1,000 h. p. each. These small developments, however, are not a factor in the commercial power problem and are here disregarded. The owners of developed commercial power in the two States under consideration also own 118,000 h. p. undeveloped. The importance of this undeveloped power and the significance of its ownership will appear later. For North Carolina, Table 8, page 76, shows that 69,000 h. p., or more than two-thirds of all the power in the State, developed and under construction, is owned by the Carolina Power & Light Co. and the North Carolina Power & Electric Co.[1] The developments actually in operation in this State are comparatively small, no one having as much as 5,000 h. p. In South Carolina 101,680 out of 135,040 commercially developed horsepower is owned by the Southern Power Co. Only three other companies have as much as 5,000 h. p. each, the largest of these having 11,620 h. p.

The developed water power in North Carolina and South Carolina, arranged by streams, is shown in Tables 10 and 11, respectively, below:

TABLE 10.—DEVELOPED WATER POWER IN NORTH CAROLINA, BY STREAMS, CLASSIFIED AS COMMERCIAL OR MANUFACTURING DEVELOPMENTS.

Stream.	Commercial.	Manufacturing.	Total.
	h. p.	h. p.	h. p.
Roanoke River	1,500	4,100	5,600
Smith River[2]	.....	1,150	1,150
Catawba River	500	2,050	2,550
Broad River	.....	3,600	3,600
French Broad River	8,060	.....	8,060
Pigeon River	1,900	.....	1,900
Yadkin-Pee Dee River	[3] 66,000	1,750	67,750
Cape Fear River	4,200	.....	4,200
Neuse River	800	.....	800
Tar River	.....	1,400	1,400
Total	82,960	14,050	97,010

TABLE 11.—DEVELOPED WATER POWER IN SOUTH CAROLINA, BY STREAMS, CLASSIFIED AS COMMERCIAL OR MANUFACTURING DEVELOPMENTS.

Stream.	Commercial.	Manufacturing.	Total.
	h. p.	h. p.	h. p.
Savannah River	3,000	1,175	4,175
Seneca River	7,600	1,130	8,730
Saluda River	6,880	17,800	24,680
Broad River	44,760	27,352	72,112
Catawba River	72,800	.....	72,800
Total	135,040	47,457	182,497

[1] The plant of the North Carolina Power & Electric Co. is not yet in operation and 32,000 h. p. of the Carolina Power & Light Co. (owned through the Yadkin River Power Co.) is under construction.

[2] Tributary of the Dan.

[3] Includes 64,000 h. p. under construction.

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From the above tables it is found that nearly 80 per cent of all the commercial power, developed and under construction, in North Carolina is on the Yadkin River. Practically all of this is owned in equal parts by two companies. The development for South Carolina shows that 117,560 h. p. out of a total of 135,040 commercially developed is on the Broad and Catawba Rivers, and Table 8 indicates that 75 per cent of the total is owned by one company.

The principal owners of commercial power, developed and under construction, in these States are shown in the following table:

TABLE 12.—PRINCIPAL OWNERS OF COMMERCIAL WATER POWER, DEVELOPED AND UNDER CONSTRUCTION, IN NORTH CAROLINA AND SOUTH CAROLINA, AND THE UNDEVELOPED POWER OWNED BY THESE OWNERS.

Owner.	State.	Power developed and under construction.	Undeveloped power.	Total.
		h. p.	h. p.	h. p.
Southern Power Co	South Carolina	101,680	[1] 104,000	205,680
Electric Manufacturing & Power Co	do	11,620		11,620
Columbia Electric Street Railway, Light & Power Co.	do	8,140		8,140
Anderson Water, Light & Power Co	do	7,600		7,600
Carolina Power & Light Co	North Carolina	37,000		37,000
North Carolina Power & Electric Co	do	32,000		32,000
North Carolina Electrical Power Co	do	7,800	7,500	15,300

[1] 31,000 h. p. in North Carolina.

This table shows that the Southern Power Co. is by far the largest single owner of commercial power, both developed and undeveloped, in these States, owning more than all others combined. In fact, omitting the Carolina Power & Light Co. and the North Carolina Power & Electric Co., all other owners are comparatively small.

SOUTHERN POWER CO.—This company was incorporated in 1905. Its capitalization outstanding consists of $6,000,000 preferred stock, $4,000,000 common stock, and $3,000,000 in bonds. It owns the entire capital stock ($800,000) of the Catawba Power Co. The Southern Power Co. is owned and controlled by J. B. Duke, B. N. Duke (both of the American Tobacco Co.), W. G. Wylie, R. H. Wylie, W. S. Lee, and their associates.

All the water-power properties of the Southern Power Co. are situated in North Carolina and South Carolina, mainly in the latter State. The principal properties are on the Catawba (or Wateree) and Broad Rivers, with other properties on the Haw and Cape Fear Rivers in North Carolina. Its hydroelectric plants are at Catawba, Great Falls, and Rocky Creek on the Catawba, and at Greenville on the Saluda in South Carolina, with a plant at Ninety-Nine Islands on Broad

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River. The water-power properties, both developed and undeveloped, are shown in the following table:

TABLE 13.—WATER POWER OWNED BY THE SOUTHERN POWER CO.

Location.	Developed and under construction.	Undeveloped.	Total.
	h. p.	h. p.	h. p.
Great Falls, Catawba River, S. C.	32,000	.....	32,000
Rocky Creek, Catawba River, S. C.	32,000	.....	32,000
Catawba, Catawba River, S. C.	8,800	.....	8,800
Ninety-Nine Islands, Broad River, S. C.	24,000	.....	24,000
Greenville, Saluda River, S. C.	4,880	10,000	14,880
Wateree (near Camden), Wateree River, S. C.	.....	20,000	20,000
Rich Hill, Wateree River, S. C.	.....	16,000	16,000
Fishing Creek, Catawba River, S. C.	.....	15,000	15,000
Landsford, Catawba River, S. C.	.....	12,000	12,000
Mountain Island, Catawba River, N. C.	.....	6,000	6,000
Horseford Shoals, Catawba River, N. C.	.....	3,000	3,000
Lookout Shoals, Catawba River, N. C.	.....	6,000	6,000
Near Pittsboro, Haw River, N. C.	.....	6,000	6,000
Near Dunn, Cape Fear River, N. C.	.....	10,000	10,000
Total.	101,680	104,000	205,680

The above table shows that the Southern Power Co. owns 101,680 h. p., developed and under construction, and 104,000 undeveloped, a grand total of 205,680 h. p. All its developed power is in South Carolina and 73,000 h. p. of the undeveloped is in that State. In North Carolina it owns 15,000 undeveloped horsepower on the Catawba River, 6,000 undeveloped on the Haw River, and 10,000 undeveloped on the Cape Fear River.

OTHER POWER OWNERS IN THE CAROLINAS.—The other principal water-power owners in South Carolina have comparatively small developments and can not supply any considerable power outside the immediate locality of production. The second largest owner in South Carolina is the Electric Manufacturing & Power Co. at Gaffney, with 11,620 h. p. It sells power in Gaffney, Cowpens, Woodruff, and Spartanburg, and it can not nearly supply the demand in these markets; the Southern Power Co. sells considerable power in some of them. The Columbia Electric Street Railway, Light & Power Co. has a development of 8,140 h. p. at Columbia. This company does the entire street-railway, electric light and power business of that city. After supplying the electric railways and lights for the city it can not have a large amount of power remaining for sale to manufacturing concerns. The Southern Power Co. has a transmission line projected to Columbia. The Savannah River Power Co. has a development on the Savannah River west of Abbeville, and the Anderson

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Water, Light & Power Co., which is owned by the same stockholders that control the Savannah River Power Co., has a development on the Seneca River a few miles west of Anderson. These concerns together have 10,600 developed horsepower, and sell power in Abbeville, Anderson, and Greenwood. All the territory of these smaller companies in South Carolina is within easy reach of the Southern Power Co.

In North Carolina there are two companies that have large developments, completed or under construction. The larger and more important of these companies is the Carolina Power & Light Co. The properties of the old Rockingham Power Co. have been taken over by a new company, known as the Yadkin River Power Co. This new company is controlled by the Carolina Power & Light Co., which thus adds to its water-power holdings a plant of 32,000 h. p. now under construction. The plants of the Carolina Power & Light Co., now in operation, have a rated wheel capacity of 5,000 h. p. which, with that under construction near Rockingham, will give it a total development of 37,000 h. p. The other large holder of water power in this State is the North Carolina Power & Electric Co., which recently acquired the properties of the Whitney Co. on the Yadkin River at Whitney. This development has a rated capacity of 32,000 h. p. The natural territory of these two companies is partly covered by the Southern Power Co. The plant at Whitney is within easy transmission distance of Charlotte, Concord, Salisbury, and Greensboro, large markets now reached by the Southern Power Co. Within this same territory is a large number of cotton mills outside of the cities named, many of which are now reached by the Southern Power Co. That company has now a great advantage in this territory, by reason of the fact that its transmission lines are already built therein and it has secured a large number of customers. The principal free territory for the plant at Whitney lies to the east, but the market opportunities in that region are not so great as to the west. Furthermore, it will be seen from the map that the undeveloped sites of the Southern Power Co. on the Haw and Cape Fear Rivers are just as convenient to unoccupied territory as is the North Carolina Power & Electric Co., so that in whatever direction the latter company may turn it will meet the Southern Power Co. as a possible competitor.

The situation of the Carolina Power & Light Co. is more favorable than that of the North Carolina Power & Electric Co., but markets now occupied by it will be the natural outlet for the undeveloped power of the Southern Power Co. In this connection, however, it is important to note that the Carolina Power & Light Co. is controlled by General Electric interests, so that its financial position is as strong as that of the Southern Power Co.

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In the vicinity of Asheville the North Carolina Electrical Power Co. owns sites with ample markets for all its power within a comparatively short radius. The undeveloped sites of the Southern Power Co. on the Catawba River in North Carolina will have ample markets in the immediate vicinity without interference with the developments around Asheville.

Strong market position of the Southern Power Co.—Opposite page 124 is a map showing the location of all the water-power developments in North Carolina and South Carolina belonging to owners who have as much as 3,000 h. p., both developed and undeveloped. Distinction is made between commercial and manufacturing developments, and the territory served by commercial concerns is indicated by their transmission lines. A graphic presentation of the percentage of the commercially developed power in each of these States held by the principal owners is shown on the map.

The five developments of the Southern Power Co. are comparatively near each other. The Great Falls and Rocky Creek plants are only a few miles apart on the Catawba River. Less than 30 miles north of the Great Falls plant is the Catawba plant on the same stream, and about 30 miles west of the Catawba plant is that of Ninety-Nine Islands on the Broad River, while that at Greenville is some 50 miles farther west. The transmission lines now built extend westward as far as Easley, about 10 miles west of Greenville, S. C., north to Hickory and Statesville, N. C., east to Monroe and Albermarle in North Carolina, and northeast to Winston Salem, Greensboro, and Durham, N. C. These lines comprise a three-wire circuit equivalent to more than 1,000 miles in length, and the extreme distance from Easley, S. C., to Durham, N. C., as measured by the tracks of the Southern Railway, is about 265 miles.

The properties of this company cover a great cotton-manufacturing district. The territory now reached by its transmission lines includes between 150 and 200 cotton mills with a capacity of more than 5,000,000 spindles and 120,000 looms. Power is now supplied by this company to more than 148 cotton mills operating more than 2,000,000 spindles and 42,500 looms. Within this territory are numerous other manufacturing enterprises, a large number of traction companies, and more than a score of prosperous cities and towns available as customers for power and light.

It is also gaining a strong foothold in the territory of a number of smaller though important water-power owners. Transmission lines are projected in the southwest and west to Greenwood, Anderson, and other points in South Carolina, where they will enter territory now occupied by the Savannah River Power Co.; to the south its projected lines will reach Columbia and Sumter, and beyond. At

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Columbia it will enter the territory of the Columbia Electric Street Railway, Light & Power Co.; and with the development of its power sites on the Haw and Cape Fear Rivers in North Carolina, it will enter the territory now covered by the Carolina Power & Light Co. and will be in close touch with Raleigh, Durham, and other important manufacturing points in that region. It is now delivering power to Monroe, N. C., which is within 40 miles of the development near Rockingham, now being made by the Yadkin River Power Co. (owned by the Carolina Power & Light Co.), and it is likewise delivering power at Albemarle, N. C., which is within a few miles of the great water powers of the Yadkin River, where a development is under way by the North Carolina Power & Electric Co. At various other points, such as Winston Salem and Hickory, N. C., and Gaffney and Spartanburg, S. C., it enters the territory of smaller hydroelectric plants. It is readily seen, therefore, that the developments of this company now in operation and projected, the wide territory covered, the large demand for power within this territory, together with the strong financial interests that are behind it, make the Southern Power Co. by far the most important hydroelectric development concern in the Southern States.

Next in importance to the Carolina Power & Light Co. in respect to financial strength is the Savannah River Power Co. in South Carolina. This concern is allied with the S. Morgan Smith Co. The extension of the Southern Power Co. into the territory of the S. Morgan Smith interests and into that of the General Electric interests may readily result in some form of combination or agreement. The subject is admitted to have been discussed with the Smith interests, and power contracts between the Southern Power Co. and the Yadkin River Power Co., a subsidiary of the Carolina Power & Light Co., have been contemplated.

The commanding position of the Southern Power Co. in the Carolinas is thus clearly indicated not only by the volume of power owned but by the strong foothold it already has in a large number of very important markets. In South Carolina it owns 75 per cent of all the developed commercial power. On the Catawba River, the greatest power-producing stream in the State, it owns all the developed commercial power. On the Broad River, the second largest power-producing stream, it owns 53 per cent of the commercially developed power. It owns a large portion of the undeveloped power on these two streams in this State that is owned by concerns having commercial developments. In North Carolina it owns 15,000 undeveloped horsepower on the Catawba River, and 16,000 undeveloped horsepower on the Haw and Cape Fear Rivers. It is now selling power at the very door of the North Carolina Power & Electric Co.,

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and it is in a strong position to divide business with the Carolina Power & Light Co. in markets that may be available to the latter's new plant near Rockingham.

Public-service corporations controlled by the Southern Power Co.— Within comparatively recent months the Southern Power Co. has extended its operations into the municipal public-service business. It has acquired the street-railway, electric-light, and gas companies at Charlotte, N. C., and Greenville, S. C.; it has also secured the street-railway and electric-light plant at Thomasville, N. C. The same interests that dominate the Southern Power Co. have projected an electric railroad from Anderson, S. C., to Charlotte and eventually to Durham, N. C. These interests have purchased a short interurban line at Anderson and are now actively engaged in constructing the longer line.

Section 7. Concentration in Georgia.

The total commercial water power in Georgia, developed and under construction, is 126,927 h. p., and of this five companies, nominally independent, control 109,050 h. p., as follows:

Company.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Atlanta Water & Electric Power Co.	16,800	.....
Georgia Power Co.	53,250	80,000
Central Georgia Power Co.	24,000	120,000
Columbus Power Co	11,500	63,500
Albany Power & Manufacturing Co.	3,500	16,000
Total.	109,050	279,500

These five companies own 86 per cent of the total commercial power, developed and under construction, in the State. If 12,027 h. p. owned by the city of Augusta and sold as water to various concerns be excluded, these five companies own 95 per cent. Two of the above companies, namely, the Atlanta Water & Electric Power Co. and the Georgia Power Co., are controlled by the same interests, and the Albany Power & Manufacturing Co. is probably under the same control. These three companies may therefore be treated as one, so that the power shown in the above statement is practically under the control of three interests. The operations of the Atlanta Water & Electric Power Co. and the Georgia Power Co. center in Atlanta; the Central Georgia Power Co. operates in the vicinity of Macon in the central portion of the State; the Albany Power & Manufacturing Co. has a plant at Albany; the Columbus Power Co. operates at Columbus and vicinity.

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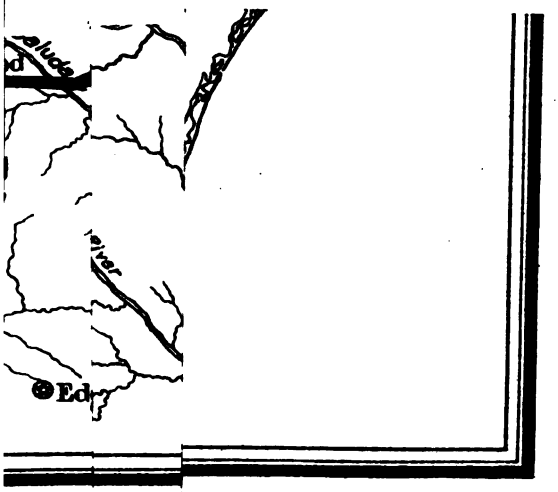

WER DEVELOPMENT IN THE UNITED STATES.

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ATLANTA WATER & ELECTRIC POWER CO. AND GEORGIA POWER CO.—These two companies are dominated by individuals who control the large water-wheel manufacturing establishment of S. Morgan Smith Co. at York, Pa.[1] The two companies together have 70,050 h. p., developed and under construction, and 80,000 h. p. undeveloped.

The Atlanta Water & Electric Power Co. was incorporated in Georgia in 1902; its capital liabilities consist of $1,500,000 in stock and $1,400,000 in bonds. The Westinghouse Electric & Manufacturing Co. owns $400,000 of the stock, and George C. Smith, who is prominent in Westinghouse affairs, is a director in the company. The secretary and treasurer of this company states that, while the Westinghouse interests own this large block of the stock, as a matter of fact it is controlled absolutely by S. Morgan Smith interests. C. Elmer Smith, who is the dominant spirit in the S. Morgan Smith Co., is president of the Atlanta Water & Electric Power Co., and S. Fahs Smith of the same company is a director.

The wheel development of 16,800 h. p. of the Atlanta Water & Electric Power Co. is on the Chattahoochee River, about 18 miles from Atlanta. The company has a contract for the sale of all its power to the Georgia Railway & Electric Co., which does the entire street-railway, electric-lighting, gas, and steam-heating business, and a part of the general power business in Atlanta.

The Georgia Power Co. was recently organized and took over all the properties of the North Georgia Electric Co. except the Gainesville Railway & Power Co. The North Georgia Electric Co. was incorporated in Georgia in 1901 to develop water power and at that time took over the Gainesville Street Railway properties. It passed into the hands of a receiver and at a receiver's sale was bid in by S. Morgan Smith interests and reorganized under the name of the Georgia Power Co. The bulk of the capital for the new company was procured through Canadian banks, but the management and practical control are in the hands of C. Elmer Smith. The Georgia Power Co. has a present wheel installation of 3,250 h. p. about 3 miles from Gainesville and is installing 50,000 h. p., at Tallulah Falls. It owns three large undeveloped sites, one near Cartersville and another near Newnan of 24,000 h. p. each, and a third near Buford, estimated at 32,000 h. p. The company has a transmission line completed from its development near Gainesville to Atlanta, a distance of about 50 miles, and this line will be immediately extended to the Tallulah Falls plant. At present the company sells power to the municipal lighting plants of Gainesville, Buford, and Norcross. It sells some power for manufacturing purposes in Atlanta, and with

[1] For the relation of the Smith interests to the Albany Power & Manufacturing Co. and the Savannah River Power Co., see p. 168.

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its increased developments it can supply a large portion of the power used by manufacturers in that city.

Opposite page 128 is a map of Georgia, showing the developments of 1,000 h. p. and over in the State and the transmission lines of the Atlanta Water & Electric Power Co., the Georgia Power Co., and the Central Georgia Power Co. From an examination of this map it is seen that the two first named companies occupy a very strong position with respect to markets. Atlanta is the largest and by far the most important industrial city in the State. The fact that these two companies are controlled by the same interests and the further fact that these companies control a large volume of undeveloped power in that section, give to them a practical monopoly in the most populous center and the greatest industrial community in the State.

ALBANY POWER & MANUFACTURING CO.—This company was incorporated in Georgia in 1903. Its capital liabilities consist of $600,000 stock and $418,000 in bonds. It has a developed wheel capacity of 3,500 h. p. on the Muckafoonee River, a tributary of the Flint, about 1½ miles from Albany. It owns undeveloped power on the Flint River estimated at 16,000 h. p. The company has a contract with the city of Albany to supply power to operate the municipal electric-light and water plants. Under this contract the city agrees to hold in readiness its own steam plant to meet its power demands in case of flood or any accident to the plant of the Albany Power & Manufacturing Co. The remainder of the power is sold to manufacturing concerns in Albany. C. Elmer Smith, of S. Morgan Smith Co., is a director and vice president of this company, thus connecting it with the Atlanta Water & Electric Power Co. and the Georgia Power Co.

CENTRAL GEORGIA POWER CO.—This company was incorporated in Georgia in 1907 to construct a hydroelectric plant on the Ocmulgee River, about 37 miles north of Macon, and about 43 miles from Atlanta. Its development consists of 16,000 h. p. now in operation, and provision in its power house for an additional installment of 8,000 h. p. whenever the market may warrant it. The company's transmission lines, as can be seen from the map (opposite p. 128), are built to a point on the Southern Railway near Flovilla, and thence west to Griffin; from the junction point at the railroad another line extends to Forsyth and Macon. The company has a contract to supply power to the Macon Railway & Light Co., which does the entire electric railroad, lighting, and power business in Macon. There is no interownership of stock between the two companies, but the same individuals are respectively president and vice president of both companies, and there are at least two others who are common directors.

Besides the developed water power above described, this company owns three undeveloped sites of 40,000 h. p. each, or a total of

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120,000 h. p. This company occupies a very strong position in the central portion of the State. Its water-power development is large and it owns the most important undeveloped powers in this section. Its close affiliation with the street railway and lighting company of Macon, which is the largest city in central Georgia; the extension of its lines to Griffin and Forsyth, both important communities; and its access to numerous other towns in this rapidly developing section of the State, give it a very strong market position. Should the companies now entering Atlanta be unable to supply the demand for power, the Central Georgia Power Co. is within easy transmission distance, and could readily extend its lines thither.

COLUMBUS POWER CO.—This company was incorporated in Georgia in 1906 and consolidated three power companies controlling water power on the Chattahoochee River. It is a subsidiary of the Columbus Electric Co. The Columbus Electric Co. also controls the Columbus Railroad, which has altogether 26 miles of track, 5 miles of which are leased to the Seaboard Air Line Railway. The Columbus Electric Co. and its subsidiaries do the entire electric-railway, electric-light, power, and gas business in Columbus and vicinity, including Phoenix and Girard in Alabama.

The Columbus Power Co. owns a wheel development of 11,500 h. p. near Columbus and undeveloped sites on the Chattahoochee River estimated at 63,500 h. p. The Columbus Electric Co. and its subsidiaries, including the Columbus Power Co., are operated by the Stone & Webster Management Association (p. 163). These companies practically dominate the power situation in the vicinity of Columbus. They control not only most of the water power in that section, but also the electric railways and the electric light and power distributing plants.

OTHER POWER OWNERS.—The largest owner of power outside of the companies already discussed is the city of Augusta, which has 12,027 h. p. This power is developed on the Savannah River, 7 miles above the city. It is all sold as water to the Augusta Railway & Electric Co. and to manufacturing concerns in Augusta that have their own installations.

The Eagle & Phoenix Mills (cotton manufacturers) have a development of 6,400 h. p. on the Chattahoochee River at Columbus, which is used entirely for manufacturing purposes. The Towaligo Falls Power Co. has a development of 3,600 h. p. near Griffin. This is really an association of manufacturers who have developed this power and sell it to themselves. There are four small concerns in the State that have developed power ranging between 1,000 and 3,000 h. p. each. The most important of these are the Athens Electric Railway, with 2,550 developed water horsepower, and the Gainesville Railway & Power Co., with a development of 1,500 h. p. The Athens Electric

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Railway operates the street railway of Athens, and does the lighting, public and private, of that city. The Gainesville Railway & Power Co. does the street-railway business of Gainesville, and sells a small amount of power to some manufacturing concerns.

SUMMARY OF THE POWER SITUATION IN GEORGIA.—The owners of developed water power in Georgia, including 62,000 h. p. in developments of less than 1,000 h. p. each, also control 286,350 h. p., undeveloped, making a grand total of nearly 488,000 h. p., developed and undeveloped. The minimum potential power in the State on a 75 per cent efficiency basis is estimated at 374,000 h. p., and the assumed maximum, estimated on the same basis, is 627,000 h. p. The five companies shown in the statement at page 124 own 388,550 h. p. It is thus seen that water power aggregating more than the total estimated minimum for the State is owned by five companies, and concerns now operating control more than 77 per cent of the total estimated maximum. Moreover, two very important companies, namely, the Atlanta Water & Electric Power Co. and the Georgia Power Co., are controlled by the same interests, and another, the Albany Power & Manufacturing Co., is closely affiliated with them. By reference to the map, it will be seen that properties of these five corporations are so situated as readily to lend themselves to a complete consolidation, should a merger be thought desirable.

Section 8. Concentration in the Southern Peninsula of Michigan.

The total water power, developed and under construction, in Michigan, including ownerships of 1,000 h. p. and over, as reported to this Bureau, is 133,102 h. p. Of this total, 102,682 h. p. is commercial power. Approximately 69 per cent of this commercial power, or 70,632 h. p., is in the Southern Peninsula. The individual owners of 3,000 h. p. and over, including both developed and undeveloped power in Michigan, are shown in Table 8, page 72. The developed power in the Southern Peninsula, compiled by streams, is shown in the following table:

TABLE 14.—DEVELOPED WATER POWER IN THE SOUTHERN PENINSULA OF MICHIGAN, BY STREAMS, CLASSIFIED AS COMMERCIAL OR MANUFACTURING DEVELOPMENTS.

Stream.	Commercial.	Manufacturing.	Total.
	h. p.	h. p.	h. p.
St. Joseph River[1]	12,532	4,970	17,502
Kalamazoo River	9,500	4,200	13,700
Grand River	10,000	3,900	13,900
Muskegon River	22,000	3,000	25,000
Au Sable River	12,000	.....	12,000
Huron River	1,500	.....	1,500
Other rivers	3,100	1,600	4,700
Total	70,632	17,670	88,302

[1] Including tributaries.

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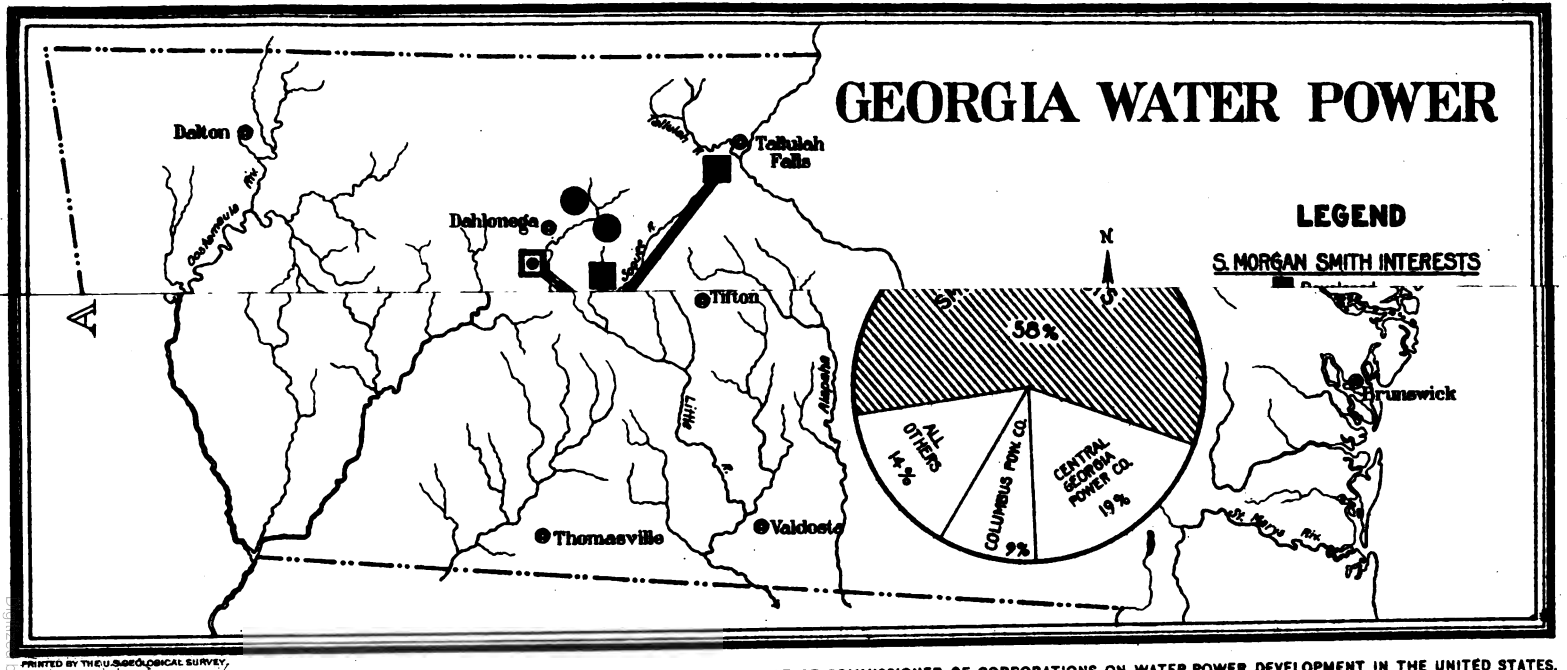

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This table shows that nearly all the power in this portion of the State, developed and under construction, is on five streams, namely, the St. Joseph, Kalamazoo, Grand, Muskegon, and Au Sable. There are large undeveloped powers on the Manistee River, and this stream, with the other five just mentioned, contains practically all the important water powers in the Southern Peninsula.

Of the commercial power, developed and under construction, 93 per cent is on the five rivers above enumerated. The bulk of this power is on the Kalamazoo, the Grand, and the Muskegon, which together have 41,500 h. p. The control of all the power on these three streams, except 2,200 h. p., is in the Commonwealth Power, Railway & Light Co. which dominates the power situation in the Southern Peninsula.

COMMONWEALTH POWER, RAILWAY & LIGHT CO.—This company is a Maine corporation, chartered in 1910, to acquire control of a number of the most important water-power and municipal public-service corporations in Michigan. It was organized by W. A. Foote and financed by E. W. Clark & Co., of Philadelphia, and Hodenpyl, Walbridge & Co., of New York. Members of the two financing firms are officers and directors in the parent company, and also in a number of the subsidiary corporations. The principal water-power companies acquired under this arrangement were the Grand Rapids-Muskegon Power Co. and the Commonwealth Power Co., which at the time of their acquisition controlled a number of electric light and gas companies. The water-power properties of the Commonwealth Power, Railway & Light Co., developed and under construction, and undeveloped, are shown in the following table:

TABLE 15.—WATER-POWER PROPERTIES OWNED OR CONTROLLED BY COMMONWEALTH POWER, RAILWAY & LIGHT CO.

Company.	Developed and under construction.	Undeveloped.	Total.
	h. p.	h. p.	h. p.
Commonwealth Power Co	15,300	5,000	20,300
Grand Rapids-Muskegon Power Co	24,000	8,000	32,000
Shiawassee Light & Power Co	500	.....	500
Au Sable development	12,000	28,000	40,000
Total	51,800	41,000	92,800

This table shows that the Commonwealth Power, Railway & Light Co. controls 51,800 h. p., developed and under construction, which is 73 per cent of the commercial power developed and under construction in the Southern Peninsula. In addition to the developed power, the company owns 41,000 h. p., undeveloped, and the same interests probably control 30,000 h. p. more, undeveloped, on the

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Manistee River. It also owns steam plants generating a total of 24,350 h. p. It is readily seen by a comparison of the figures in Tables 8 and 15 that this company occupies a very strong position in the water-power situation.

Strong market position of the Commonwealth Power, Railway & Light Co.—The dominant position of the Commonwealth Power, Railway & Light Co. is only partially indicated by the great volume of power owned. Its position is further strengthened by the ownership or control of street railway and lighting corporations that consume a large portion of the power produced and of gas companies that might be competitors of any other electric-lighting concern.

In the acquisition of properties at the time of the organization of the company in March, 1910, there came under its control the street railways of Grand Rapids, Saginaw, and Bay City, and the interurban electric line between Saginaw and Bay City. These companies have 177 miles of track. There were also acquired electric-lighting plants in 18 cities and towns, as follows: Grand Rapids, Saginaw, Bay City, Kalamazoo, Battle Creek, Jackson, Flint, Pontiac, Cadillac, Big Rapids, Coopersville, Grandville, Lowell, Albion, Galesburg, Grand Ledge, Otsego, and Allegan. At the same time gas companies were acquired in Kalamazoo, Jackson, Pontiac, Saginaw, Bay City, and Flint.

Opposite this page is a map of the Southern Peninsula of Michigan, showing, among other things, the location of the water-power plants and undeveloped sites of the Commonwealth Power, Railway & Light Co., together with its transmission lines. This map shows that the territory from Kalamazoo east to Jackson and from Jackson north to Lansing is covered by one group of its transmission lines; and that the territory to the north, including the cities of Grand Rapids, Muskegon, and smaller towns, is covered by another set of lines. In the eastern portion of the State a development of this company is practically completed on the Au Sable River with a transmission line to Bay City, Saginaw, and Flint. This plant has a rated capacity of 12,000 h. p. and the company owns undeveloped power on this stream estimated at 28,000 h. p. With the exception of Detroit and Port Huron the transmission lines of this company reach the most important manufacturing centers of the State. As already pointed out, it controls the street railways in the three largest cities reached; it controls the electric-lighting plants in all the important towns reached by its lines except Marshall and Lansing, and it has access for the sale of its power in large manufacturing centers.

The company has practically no rival in the State. In the extreme southwestern corner the Indiana & Michigan Electric Co. has developments on the St. Joseph River amounting to 9,200 h. p. This com-

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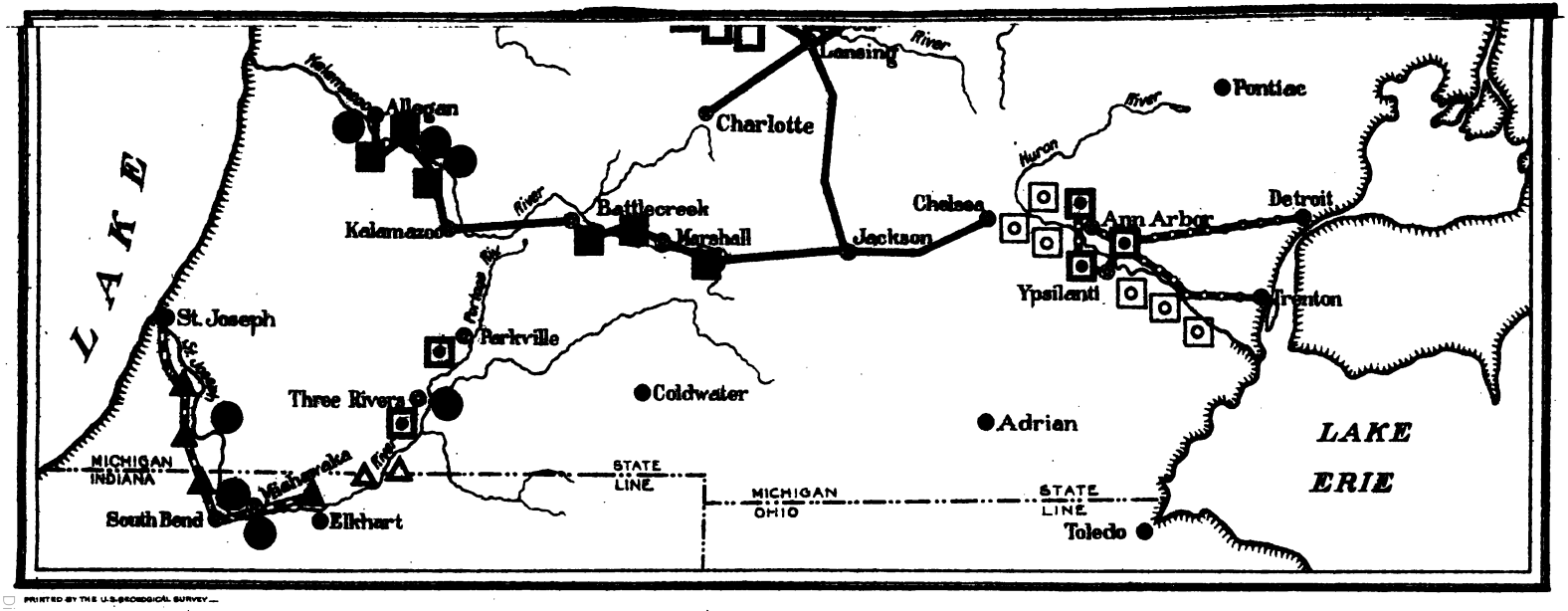

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REPORT OF COMMISSIONER OF CORPORATIONS ON WATER-POWER DEVELOPMENT IN THE UNITED STATES.

pany also owns power sites on the same stream in the State of Indiana, and its principal markets are Elkhart and South Bend in that State. It does not enter the territory of the Commonwealth Power, Railway & Light Co., and there is no apparent reason why it should. The ownership of the principal water powers of the Southern Peninsula and the control of the principal concerns that are the large consumers of commercial power in the territory reached, together with the ownership of practically all the undeveloped power of any considerable importance, establishes a practical monopoly of this great resource in the hands of a single interest.

Section 9. Concentration in Wisconsin.

While the concentration of water-power ownership and control in Wisconsin has not progressed as far as in the Southern Peninsula of Michigan, a movement in that direction is clearly manifest.

A very large proportion of the water power in this State is used for manufacturing purposes. In view of the fact, however, that much of this manufacturing power is used in the pulp and paper and lumber industries, it is reasonable to include it in this discussion. These industries depend to a great extent upon a supply of raw material that is rapidly disappearing. It is safe to assume that when the power can no longer be utilized for the operation of pulp, paper, and lumber mills it will be diverted into commercial channels.

The principal power streams of the State are the Fox, Wisconsin, Chippewa, and Menominee Rivers.

Fox River.—Out of a total of approximately 38,660 h. p. developed on this stream, a single concern, the Green Bay & Mississippi Canal Co., owns 22,835 h. p. Most of the developed power on the Fox River, while used for manufacturing, has been classified as commercial power, since it is sold to manufacturing and other concerns by this company. This company also owns practically all the undeveloped power on this river, at least 9,200 h. p., making a total controlled by it of 32,035 developed and undeveloped, out of 47,860 h. p. in all, developed and undeveloped, on the Fox River between Lake Winnebago and Green Bay, or over 66 per cent. A single other concern, the Kimberly-Clark Co., a paper and pulp manufacturing concern, owns 7,200 h. p. on the same river, which it uses for manufacturing purposes. There is only about 8,600 h. p. on the Fox River, developed and undeveloped, which is not controlled by these two concerns.

Wisconsin River.—The total of the developed power on this stream is 76,754 h. p., all of which, except about 10,000 h. p., is at present used for manufacturing pulp and paper, but there is the possibility that this power will in time become "commercial."

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Four well-defined interests or groups own or control 54,707 h. p., or over 70 per cent of the developed water power on the river. These four interests are the Wausau group, the Grand Rapids group (consisting of the Consolidated Water Power & Paper Co. and the Grand Rapids Pulp & Paper Co.), the McNaughton-Alexander, and the Swensen interests.

The Wausau group consists of the Wausau Paper Mills Co., the Wausau Street Railroad Co., Marathon Paper Mills Co., Rhinelander Power Co., and Rhinelander Paper Co.; they control also two sites at Lower Grandfather Falls and Trappe Rapids. This one group controls 19,257 h. p. developed, and at least 20,500 h. p. undeveloped; that is, about one-fourth of the developed and over one-third of the undeveloped power on the river.

The McNaughton-Alexander interests consist of two companies, the Nekoosa-Edwards Paper Co. and the Centralia Pulp & Water Power Co., both with the same manager, and dominated by the interests that control the Green Bay & Mississippi Canal Co., on the Fox River. These companies control 13,500 h. p., developed.

The Southern Wisconsin Power Co., with developed and undeveloped water power at Kilbourn, Wis., and the Prairie du Sac Power Co., with undeveloped power on the Wisconsin River, dominated by Magnus Swensen and associates, have 8,000 h. p. developed and 16,000 h. p. undeveloped.

Of the undeveloped water power on the Wisconsin River, estimated, roughly, at 67,250 h. p., at least 36,500 h. p. is known to be owned or controlled by two interests, namely, the Wausau group and the Swensen interests.

CHIPPEWA-FLAMBEAU SYSTEM.—On the Chippewa River and its tributaries, and the Flambeau and Red Cedar Rivers, two affiliated companies, the Chippewa Valley Railway, Light & Power Co. and the Chippewa Lumber & Boom Co., control 19,556 h. p. developed and 18,400 h. p. undeveloped, out of a total of 40,735 h. p. developed and at least 55,850 h. p. undeveloped. The president of one company is vice president of the other, and the two companies have another director in common.

On the Chippewa-Flambeau system the use of water power for generation of electricity amounts at the present time to about 7,000 h. p. out of a total of about 41,000 h. p. developed, and commercial use is constantly increasing.

MENOMINEE RIVER.—Two distinct groups or interests are dominant on this stream, which forms the boundary for some distance between Wisconsin and northern Michigan. The Oliver Iron Mining Co. (subsidiary of the United States Steel Corporation), together with its affiliated concern, the Iron Mountain Electric Light & Power Co., own 3,850 h. p. developed and about 20,000 h. p. undeveloped. The

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Menominee River Boom Co., N. Ludington Co., and Menominee & Marinette Light & Traction Co., three affiliated concerns constituting the Stephenson interests, together control wholly or in part 10,250 h. p. developed and under construction and 16,800 h. p. undeveloped. The two groups thus control 14,100 h. p. developed and at least 36,000 h. p. undeveloped on this stream, out of a total of 27,300 h. p. developed and 55,700 h. p. undeveloped.[1] Some of this power is developed on the Michigan side of the river, and in Table 8 (p. 72) is credited to that State.

The water power on the Menominee River has been mainly used by manufacturing and mining companies for their own industries; but public-service corporations are beginning to develop it for light, traction, and general power purposes, as is seen in the construction of a plant by the Menominee & Marinette Light & Traction Co., and the proposed development of the Iron Mountain Electric Light & Power Co.

OTHER RIVERS IN WISCONSIN.—The power on the Black River is dominated, though not entirely controlled, by the La Crosse Water Power Co.; that on the St. Croix River is mainly controlled by three concerns, the Minneapolis General Electric Co., St. Croix Power Co., and the Apple River Power Co.; and on the Peshtigo River developments, at Johnsons Falls and High Falls, are being constructed.

SUMMARY.—A single company owns two-thirds of the water power developed and undeveloped on the Fox River. On the Wisconsin River a single group controls one-fourth of the developed and one-third of the undeveloped power; on the Chippewa-Flambeau system a single interest controls a little less than one-half of the developed and about one-third of the undeveloped; on the Menominee two interests control over one-half of the developed and three-fifths of the undeveloped water power. These are the foremost power streams in the State and the power developed on them is about 80 per cent of the total developed water power in Wisconsin.

Section 10. Conditions at Niagara Falls.

The greatest water power in the United States is at Niagara Falls. According to careful measurements made by Government engineers the fall between the upper rapids and the base of the Falls will produce, theoretically, energy equivalent to about 5,800,000 h. p. In water-power developments, however, the actual energy derived is very much less than the theoretical power. Probably under favorable circumstances two-thirds of the theoretical power at Niagara might be obtained.

[1] In the absence of engineers' detailed estimates it is difficult to determine the amount of horsepower which can be practically developed on this and other streams. The estimates here given were secured from the companies themselves or from engineering authorities believed to be competent.

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From 1879 to 1894 nine corporations were chartered by the Legislature of New York for the purpose of utilizing the waters of Niagara. The Canadian Government did not authorize the use of the water on the Canadian side until 1892. In that year the Queen Victoria Niagara Falls Park Commissioners made the first agreement with a power company. This was followed in 1894 and 1895 by Canadian charters to other companies. By the end of 1903 the Canadian Government, directly, or through the Queen Victoria Niagara Falls Park Commissioners, had chartered six water-power corporations.

Only two of the New York charters and only three of those granted by Canada limited the volume of water the corporations could use. These unlimited grants brought forth a strong protest against what appeared to be a policy that would destroy the scenic beauties of the Falls. Restrictive Federal and State legislation followed. The Legislature of New York canceled a number of charters theretofore granted. In June, 1906, Congress passed an act regulating the use of the waters of Niagara River and for the preservation of the Falls. This act authorized the Secretary of War to grant permits for the diversion of water from the river for the creation of power and limited such diversion to the extent that it should not injure or interfere with the navigability of Niagara River nor the scenic grandeur of Niagara Falls. The act also provided that the Secretary could grant permits to water-power companies operating on the Canadian side to transmit power from Canada into the United States.

Up to that time there was no understanding between the Governments of Canada and the United States as to the volume of water that might be withdrawn from Niagara River above the Falls, nor as to the relative proportions that might be claimed in each jurisdiction. It was generally understood, however, that half of the flow of the stream belonged to each Government.

In May, 1910, a treaty between the United States and Great Britain was signed, under which it was stipulated that the volume to be diverted on the American side should be limited to 20,000 cubic feet per second, and on the Canadian side to 36,000 cubic feet per second. This difference is accounted for, first, because the United States Government had previously acquired the right to divert 10,000 cubic feet per second at Chicago, for the Chicago Drainage Canal, and second, because of the deeper channel and the greater flow of water at Niagara on the Canadian side. The volume of water that can be diverted at the Falls is thus limited to 56,000 cubic feet per second until such time as the two Governments may determine to increase the amount. This is approximately 25 per cent of the total flow of the river, as computed by the Government engineers, and if fully developed would be equivalent to something more than 1,300,000 computed horsepower.

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The limit of development thus prescribed has not yet been reached on either side of the river. There has been allotted to development companies on the American side about 15,600 second-feet.

POWER COMPANIES AT NIAGARA FALLS.—There are at least six companies now in operation that have permits to use water. Two of these are on the American side and four on the Canadian side, as follows:

	Installation (h. p.).
On the American side:	
Hydraulic Power Co. of Niagara Falls	144,000
Niagara Falls Power Co	118,300
On the Canadian side:	
The Ontario Power Co. of Niagara Falls	[1] 120,000
The Canadian Niagara Power Co.[2]	62,500
The Electrical Development Co. of Ontario (Ltd.)	52,000
The International Railway Co	3,000
Total	499,800

HYDRAULIC POWER CO. OF NIAGARA FALLS.—This company is a successor to the Niagara Falls Hydraulic Power & Manufacturing Co. It has installed and under construction a wheel capacity of 144,000 h. p. Practically all its current is sold to manufacturing concerns at Niagara Falls, N. Y. The company seems to be controlled mainly by local capital at Buffalo and Niagara Falls.

NIAGARA FALLS POWER CO.—This company generates its power on the American side. It has two power houses with a total wheel capacity of 110,500 h. p., and in addition to this it sells 7,800 h. p. as water to the International Paper Co. It owns all the stock of the Canadian Niagara Power Co. (one of the Canadian companies named above), and all the stock of the Niagara Junction Railway. The company also owns a majority of the stock of the Cataract Power & Conduit Co. and all the stock of the Tonawanda Power Co.

The Canadian Niagara Power Co. owns a development of 62,500 h. p. on the Canadian side. This company and the Niagara Falls Power Co. are operated as one concern, with a total capacity, expressed in wheel power and including the 7,800 h. p. sold as water, of 180,800 h. p. The plants of the two companies are coupled by conduits under the river. These companies supply current to the Cataract Power & Conduit Co. and the Tonawanda Power Co., the former distributing power in Buffalo, the latter in Tonawanda and North Tonawanda. The Buffalo distributing company sells current to the street railways of Buffalo, the Buffalo General Electric Co.—a local lighting company—and other concerns.

ONTARIO POWER CO. OF NIAGARA FALLS.—This company has its plant on the Canadian side of the river, with a capacity of

[1] Part of this is under construction.

[2] All the stock of this company is owned by the Niagara Falls Power Co.

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120,000 h. p., installed and under construction. The plant is designed for an ultimate capacity of between 180,000 and 200,000 h. p.

The Ontario Power Co. of Niagara Falls owns the Ontario Transmission Co., which distributes electricity in the Province of Ontario, and to some extent in the United States; it is affiliated through stock ownership with the Niagara, Lockport & Ontario Power Co., which distributes energy on the American side.

THE ELECTRICAL DEVELOPMENT CO. OF ONTARIO (LTD.).—This is a Canadian corporation with a development of 52,000 h. p. It is controlled by the Toronto Railway Co. through a subsidiary known as the Toronto Power Co. The construction work on the plant has been made with a view to an ultimate development of 125,000 electrical horsepower, or over. Its power is sold principally to railway and lighting companies in Toronto.

DISTRIBUTION OF POWER FROM THE HYDROELECTRIC COMPANIES AT NIAGARA FALLS.—The total amount of power, developed and under construction, by the companies on the American side of the Falls, as above indicated, is 262,300 h. p., and that developed and under construction on the Canadian side is 237,500 h. p., or an aggregate of 499,800 h. p. for these six companies. All the power generated on the American side of the river is consumed in the United States. Nearly all the power generated by the Canadian Niagara Power Co. on the Canadian side and probably about half of that generated by the Ontario Power Co. is also consumed in the United States, while practically all the power generated by the Electrical Development Co. of Ontario (Ltd.) is used in Canada. The United States Government fixes a limit to the volume of power that can be imported into the United States. This limit has not yet been reached.

REGULATION OF WATER POWER COMPANIES AT NIAGARA FALLS.—The power companies on the Canadian side pay to the Province of Ontario an annual rental for the privilege of generating power from the Falls. The contracts for the use of water are made through the Queen Victoria Niagara Falls Park Commissioners, who also collect the rentals. The charges made by the Ontario Government appear to be $15,000 per annum for a franchise involving as much as 10,000 h. p., $1 per annum for each electrical horsepower generated and used over 10,000 h. p. and up to 20,000 h. p.; $0.75 per h. p. for all power generated and used over 20,000 and up to 30,000 h. p.; and $0.50 for each electrical horsepower generated and used over 30,000 h. p. From these rentals the receipts in 1910 were slightly less than $133,000. The companies on the American side of the river pay no rentals whatever. The privilege of utilizing this great natural resource has been given absolutely free.

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CHAPTER III.

CONCENTRATION OF OWNERSHIP AND CONTROL, GROUPED BY INTERESTS.

Section 1. Introduction.

There is a broader concentration of water-power control than is evidenced by the ownership in single localities. Sometimes coupled with local control and sometimes without any seeming purpose of local control, large aggregations of capital have each acquired an interest in several hydroelectric developments. Manufacturers of electrical and hydraulic equipment, engineering concerns, and houses making a specialty of financing hydraulic, electric, and other public-service projects are particularly prominent in this concentration movement.

The potential value of water rights has been little appreciated by the general public, and capitalists have therefore been able to obtain valuable water privileges at little cost. The situation of water rights has been similar in this respect to that of public-service franchises.

A few large interests have thus become powerful factors in the water-power situation in this country. The most important ones are discussed in this chapter. These large interests not only control vast amounts of power in widely separated localities but they often control the power situation of an entire locality. In fact, some of them practically have such control in a number of localities. It is a significant fact also that these large interests cover a much wider field than that of water power. They have in some instances manifested an aggressive policy of reaching out and gathering together under one management all sorts of municipal public-service corporations, regardless of whether they involve water power or not. This phase of their activities is discussed in a later chapter.[1] The word "municipal" as used here and elsewhere in this report means that the company operates in a municipality, and does not refer to municipal ownership.

The extent of ownership and the degree of control by large interests can not always be definitely stated. It has not always been possible to ascertain exactly the amount of securities owned by these concerns, and if such information were available it would not necessarily indicate the degree of control. If the ownership of stock has come about purely as an incident to the sale of machinery or to the financing of a project or in payment for engineering services, and stops at the mere passive ownership of stock, it may have little or no significance.

[1] See p. 186.

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But if it goes a step further and includes representation on boards of directors, or, still further, and embraces one or more of the officers of a company, then this influence is strengthened and the relationship becomes highly significant. If a corporation or its officers and directors invest their money in a project, and also participate in its management, the influence of such relationship must be great.

It must be remembered that actual ownership of a majority of the stock of a corporation is not a necessary prerequisite to control. It is a matter of common knowledge that a single large holding of stock, even though much less than a majority, may at times give practical control of a corporation, especially when the remainder of the stock is widely scattered. Again, it may easily be that a director of a company who owns very much less than a majority of its stock may control it by virtue of other business connections through which he exerts a powerful influence in financial circles or in the industrial world. It is safe to assume that the officers and directors of large equipment, engineering, and financial concerns do not enter the directorates of water-power-development companies as mere figureheads. Their presence usually indicates that they are substantial factors in the policies of the companies.

There are a number of instances, however, in which there can be no question of the absolute control of water-power developments. This is evidenced by the holding of a majority of the securities. There are also cases where water-power concerns are actually operated by these interests, or by corporations subsidiary thereto, without stock control.

A number of important water-power-development concerns are found to have among their officers and on their boards of directors men who are prominent as officers in large equipment companies or strong financial institutions, or both. The significance of this latter fact lies in the suggestion that it is becoming more and more the policy of the first-named interests to obtain a stronger foothold and a more commanding position in those activities that are most closely related to their own business.

Particular attention is directed to the fact that the corporations which own many of the largest water-power developments in the country also own or control the street railways and electric lighting plants in the territory covered by their transmission lines. In other words, the manufacturers of electric power have insured a market for a large proportion of their product by acquiring their principal customers or by forming some sort of close relationship with them. This relationship between water-power developments and municipal public-service corporations is treated in some detail elsewhere.

In discussing concentration by interests it has been necessary to duplicate, briefly, the substance of matters relating to certain water-power companies treated in the preceding chapter.

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Section 2. The General Electric group.

Under this head are included those concerns that are controlled by, allied with, or in some manner related to the General Electric Co., or one of its three subsidiary corporations, namely, the United Electric Securities Co., the Electrical Securities Corporation, and the Electric Bond & Share Co. The General Electric Co. owns all the common stock of these three companies, and the four concerns will hereafter be referred to as the "General Electric companies."[1] This phrase has a meaning entirely distinct from the phrases "General Electric group" and "General Electric interests," frequently used in this report. The latter phrases refer to all water-power companies or other public-service companies controlled by or affiliated with the General Electric Co. or one or more of the three other corporations just named.

Before discussing the extent of ownership or the degree of influence of the General Electric Co. in water-power developments it is important to point out the magnitude of its operations and the broad field covered by its activities.

THE GENERAL ELECTRIC CO.—The General Electric Co. was incorporated in 1892 by a special act in New York. It acquired practically all the capital stock of the Edison General Electric Co. (and with it more than 99 per cent of the capital stock of the Edison Electric Light Co., with plants at Schenectady, N. Y.), and the Thomson-Houston Electric Co., with plants at Lynn, Mass., and Harrison, N. J. The new corporation also acquired the Thomson-Houston International Electric Co., a foreign selling agency of the Thomson-Houston Electric Co. In 1894 it acquired the assets of the Pennsylvania General Electric Co. Since that time it has acquired various other electrical-equipment concerns in this country and abroad, and it has organized or acquired important companies that hold or deal in securities.

The General Electric Co. is the largest manufacturer of electrical machinery and apparatus in the world. Its principal machinery plants are at Schenectady, N. Y., and Lynn and Pittsfield, Mass.; its plants for the manufacture of incandescent lamps are at Harrison and Newark, N. J., Fort Wayne, Ind., and Toledo, Ohio.

The growth of this company has been marked and steady. In 1894 its total assets were stated as nearly $44,000,000, including patents and franchises carried to the value of more than $8,000,000. By the end of 1910 these assets had increased to $107,767,000, not including any value placed upon patents and franchises, which were carried on the books at that time at $1. The growth of the business of the company is indicated by the fact that from 1894 to 1910 its annual sales increased from $12,500,000 to $71,478,000.

[1] For a list of the officers and directors of these companies as of Jan. 1, 1911, see p. 142.

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The resources of the General Electric Co. are set forth in the following consolidated balance sheet as of December 31, 1910:

Assets.		Liabilities.	
Patents, franchises, etc	$1	Capital stock	$65,179,600
Factory plants	15,516,314	Debentures	14,962,000
Furniture and fixtures other than in factories	1	Accrued interest on debentures	83,665
Real estate (other than factory plants)	245,719	Accrued taxes	173,405
Stocks and bonds owned	23,666,833	Accounts payable	2,796,230
Cash	14,912,400	Dividends payable	1,303,592
Notes and accounts receivable	19,047,459	Advance payments on contracts	245,819
Due from allied companies	2,923,483	Surplus	23,022,706
Work in progress	589,789		
Inventories:			
Factories	24,546,961		
General and local offices	3,249,316		
Consignments	263,664		
Copper-mining investments	2,805,077		
Total	107,767,017	Total	107,767,017

Two notable items in the assets of the company in the foregoing balance sheet are cash, and stocks and bonds owned. The cash item represents about 14 per cent of the total assets. The stocks and bonds, not including $2,805,077 in copper mining investments, amount to about 22 per cent of the total assets of the company. In other words, cash and securities, including copper mining investments, represent approximately 38 per cent of the total assets of the company. More than $6,000,000 of the stocks and bonds represent the securities of the United Electric Securities Co., the Electrical Securities Corporation, and the Electric Bond & Share Co. It should be stated in this connection that the securities owned are carried on the books of the company at their market value, which, in some instances, is considerably below their par value. The company in its reports subdivides the item of $23,666,833 of stocks and bonds owned, as follows:

Affiliated manufacturing and selling companies	$8,225,879
Security-holding companies	6,262,398
Local lighting and railway companies	8,322,206
Miscellaneous	856,350
Total	23,666,833

The extent of General Electric influence is not fully revealed by its consolidated balance sheet. A very large number of corporations are connected with it through its subsidiaries and through corporations controlled by these subsidiaries or affiliated with them. There is a still wider circle of influence due to the fact that officers and directors of the General Electric Co. and its subsidiaries are also officers or directors of many other corporations, none of whose securities are owned by any General Electric corporation. The corpora-

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ions so connected with the General Electric Co. include a number of ydroelectric developments, numerous public-service corporations, a ong list of the most powerful banking and financial institutions in he country, and many steam railroads and industrial corporations. The details of the most important of these interrelations will be presented hereafter.

A proper understanding of the scope of the operations of the General Electric Co. requires a brief description of the organization and operation of the three subsidiary corporations mentioned at the beginning of this section.

UNITED ELECTRIC SECURITIES CO.—This company was incorporated in Maine in 1890 to hold securities owned by the General Electric Co. It devotes itself particularly to buying mortgage bonds of corporations operating electric lighting, power, and railway plants, and issuing against them its own collateral trust bonds.

Its method is to deposit the bonds of various electric companies in trust and issue thereon its own collateral trust bonds. As the underlying bonds are sold, the collateral trust bonds are retired. These trust bonds are in series and each series is distinct from all others. A single series of bonds, however, may be based upon the securities of several distinct corporations. For example, the twenty-seventh series consists of a total issue of $500,000 in 5 per cent collateral trust bonds dated February 1, 1908, and due February 1, 1938. This issue is based on the underlying bonds of seven traction, lighting, and power companies in as many different States.

The United Electric Securities Co. has outstanding $1,000,000 seven per cent cumulative preferred and $500,000 common stock. Since its organization it has issued 31 series of collateral trust bonds aggregating $18,500,000. Of this amount $14,201,000 have been retired and canceled, leaving outstanding at present $4,299,000.

ELECTRICAL SECURITIES CORPORATION.—This company was incorporated in New York in 1904. Its capital stock consists of $2,000,000 common and $1,000,000 five per cent cumulative preferred. Its bonded indebtedness consists solely of collateral trust sinking fund fives in eight series to the amount of $3,308,000.

The function of the Electrical Securities Corporation is similar to that of the United Electric Securities Co., issuing collateral trust bonds in successive series, based on underlying securities. It apparently was organized to do in New York what the United Electric Securities Co. had for years done in Boston. The New York corporation has apparently been more aggressive than the Boston company. It has freely taken stock in other concerns as well as bonds. Its officers, particularly its vice president, C. N. Mason, who is its active head, have served on reorganization and merging committees in various sections of the country.

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ELECTRIC BOND & SHARE CO.—This company differs entirely from the two just considered. Its charter and by-laws render it organically different, and its operations have shown it to be a more aggressive concern. It acquires and holds the securities of other corporations; enters syndicate agreements; it has taken active part in reorganizations; it investigates projects; it manages operating concerns; and has subsidiary holding corporations of its own. In a word, it is the most active organization of the General Electric interests in their policy toward lighting, traction, and hydroelectric companies. Its by-laws authorize its executive committee to purchase for the account of the corporation stocks, bonds, and other evidences of indebtedness. It is further provided, however, that no purchase or contract of purchase shall be made unless the corporation at the time of making the contract shall have sufficient cash in bank to pay for such securities, or shall have made provision by which it shall be available at the time of the delivery of the securities. This provision means, of course, that the Electric Bond & Share Co., unlike the other two subsidiaries already discussed, can not in these respects operate on its credit.

The capital liabilities of the Electric Bond & Share Co. consist of $2,000,000 common and $2,000,000 five per cent cumulative preferred. Its general balance sheet as of December 31, 1910, showed assets to the amount of $5,821,553. About 56 per cent of its assets consisted of securities of other corporations and cash, the cash item amounting to $1,133,883.

A list of the officers and directors of the General Electric Co. and the three subsidiaries just considered is presented below:

LIST OF OFFICERS AND DIRECTORS OF THE GENERAL ELECTRIC CO., ELECTRIC BOND & SHARE CO., ELECTRICAL SECURITIES CORPORATION, AND UNITED ELECTRIC SECURITIES CO. (THE "GENERAL ELECTRIC COMPANIES"), JANUARY 1, 1911.

Name.	General Electric Co.	Electric Bond & Share Co.	Electrical Securities Corporation.	United Electric Securities Co.
Abbott, Gordon	Director		Director	Pres. and dir.
Abbott, Walter				Director.
Ames, Oliver	Director			
Barnum, W. M			Director	
Bedford, A. C		Director		
Bertron, S. R		do		
Boisot, E. K			Director	
Burchard, A. W	Asst. to pres			
Carr, E. L				Treas. and dir.
Carr, Samuel				Director.
Coffin, C. A	Pres. and dir	Director	Director	
Coffin, Winthrop				Director.
Coolidge, T. Jefferson, jr.	Director			
Dame, F. L		Vice pres		
Darling, H. W	Treasurer		Director	
Dexter, Philip				Director.
Emerson, W. R				Asst. treas.
Farrar, Frederick A		Dir. and vice pres		

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LIST OF OFFICERS AND DIRECTORS OF THE GENERAL ELECTRIC CO., ELECTRIC BOND & SHARE CO., ELECTRICAL SECURITIES CORPORATION, AND UNITED ELECTRIC SECURITIES CO. (THE "GENERAL ELECTRIC COMPANIES"), JANUARY 1, 1911—Continued.

Name.	General Electric Co.	Electric Bond & Share Co.	Electrical Securities Corporation.	United Electric Securities Co.
Fisk, Pliny			Director	
Fisk, Wilbur C			do	
Gardner, Geo. P	Director			
Gubelman, O. L			Director	
Hamilton, C. P	Director			
Hart, F. R				Director.
Higginson, H. L	Director			
Hill, E. W		Treas., asst. sec		
Hollister, G. C		Asst. sec	2d asst. sec	
Johnson, Homer H		Director		
Johnson, M. B			Director	
Kaufman, W. T			Sec., treas., and dir.	
Keeler, I. S	Asst. sec			
Lane, W. C		Director	Director	
Lovejoy, J. R	Vice pres			
Mason, C. N			Vice pres. and dir.	Director.
Mitchell, S. Z		Pres. and dir		
Moffat, Geo. B		Director		
Morgan, J. P	Director			
Morse, R. C			Director	
Murray, R. S	Asst. treas			
Ord, J. P	Director			
Paine, Robt. Treat, 2d	do	Director		Director.
Parsons, Hinsdill	Vice pres	do		
Peabody, Francis, jr				Director.
Perry, Marsden J	Director	Chmn. bd. dirs	Director	
Poniatowski, A			do	
Rice, E. W., jr	Vice pres. and dir			
Rice, N. W				Director.
Riley, John	Asst. gen. aud			
Rosen, Felix		Director		
Saltonstall, P. L		do		
Schmidlapp, J. G			Director	
Schoonmaker, S. L	Director			
Sheldon, Geo. R			Pres. and dir	
Smith, A. E		Asst. treas. and asst. sec.		
Steele, Charles	Director			
Steele, R. E	Comptroller			
Stotesbury, E. T			Director	
Strauss, Frederick		Director		
Sumner, Graham		do		
Sunny, B. E	Director			
Sykes, F. G		Vice pres		
Tilney, A. A			Director	
Walz, F. W			do	
Wetmore, C. W		Director		
Whitestone, S. L	Gen. aud			
Winterfelt, H			Director	
Westover, M. F	Secretary			
Young, A. M		Director		
Zoller, J. F	2d asst. sec			

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The affiliations of the General Electric Co. and its subsidiaries with hydroelectric concerns and the significance of this list of officers and directors will later be apparent. Influential directors in the General Electric Co. and its subsidiaries are officers or directors in a number of the largest and most important water-power corporations in the country.

WATER-POWER PROPERTIES IN THE GENERAL ELECTRIC GROUP.—The direct connection of the General Electric Co. itself with water power is slight, but the connection of the General Electric Co., including the three subsidiary corporations already discussed, is extensive. With the General Electric Co. proper the subject of water power has been one of vital interest from the first, as was quite natural in view of the close relationship between power developments and the generation and application of electricity.

From this close association with hydroelectric developments and for reasons previously stated, the General Electric Co., its principal subsidiaries and a number of the most prominent officers and directors of these interests, have gradually become interested in hydroelectric developments until a vast volume of water power has come under General Electric influence. The various water-power companies which are controlled by the General Electric companies, or which have some affiliation with or relationship to them, may be arranged in three groups according to the degree of control or the nature of relationship. These groups will be designated, in this discussion, as A, B, and C.

Group A includes those water-power companies that are completely controlled by General Electric companies or General Electric interests. In all cases but two this is through the holding of a majority of their common stocks.

Group B includes those water-power companies of whose securities a portion, but considerably less than a controlling interest, is held by the General Electric companies, and some of whose officers and directors are also officers or directors of the "General Electric companies," or are in some way connected with interests allied with the General Electric Co.

Group C includes water-power companies among whose officers and directors are individuals who are also officers or directors of the "General Electric companies," or who are in some way connected with interests allied with the General Electric Co., but are not connected by the corporate ownership of securities.

It should be noted in connection with Groups B and C that it is not possible to determine the degree of General Electric influence in these companies. The ownership of securities, in the case of Group B, may have slight significance, and a single director, as in the case of some companies in both groups, may have but little significance. It

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is highly probable, however, that such men as those shown in the table below do exercise a very considerable influence in the affairs of corporations with which they are connected.

The water-power companies involved in each of the above-described groups, and the power owned or controlled by each company are shown in the following table:

TABLE 16.—COMPANIES OWNING OR CONTROLLING WATER POWER AND CONTROLLED BY, AFFILIATED WITH, OR IN SOME WAY RELATED TO THE GENERAL ELECTRIC CO., APRIL, 1911.

Group A.—Water-power companies controlled by the "General Electric companies" or General Electric interests.

Company.	Water power.			Per cent of securities held by the "General Electric companies."	Personal connection with the "General Electric companies," showing individual and position in water-power company.
	Developed and under construction.	Undeveloped.	Total.		
	h. p.	h. p.	h. p.		
American Power & Light Co.	15,840	.....	15,840	Common stock, 16.3 [1]..	F. G. Sykes, pres. and dir.; F. L. Dame, vice pres. and dir.; E. W. Hill, vice pres.; S. Z. Mitchell, F. A. Farrar, A. C. Bedford, A. W. Burchard, A. M. Young, directors.
Asheville Electric Co....	260	3,000	3,260	Common stock, 92.4; preferred stock, 100; bonds, 100.	C. N. Mason, vice pres. and dir.
Carolina Power & Light Co.	[2] 37,000	.....	[2] 37,000	Common stock, 38.6; preferred stock, 10.8; notes, 26.9; bonds, 51.4.	C. N. Mason, F. L. Dame, S. Z. Mitchell, directors.
Consolidated Power & Light Co. of South Dakota.	2,000	2,500	4,500	Common stock, 54.7; preferred stock, 46.7; bonds, 74.1.	
Rockford Electric Co....	1,760	.....	1,760	Subsidiary of American Gas & Electric Co., a majority of whose stock is held by Electric Bond & Share Co.	
Schenectady Power Co..	26,000	.....	26,000	Owned by General Electric Co.	Hinsdill Parsons, dir.
Total.....	82,860	5,500	88,360		

[1] Electric Bond & Share Co. has under option $699,100 additional of common stock.
[2] Includes power of Yadkin River Power Co., formerly Rockingham Power Co.

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TABLE 16.—COMPANIES OWNING OR CONTROLLING WATER POWER AND CONTROLLED BY, AFFILIATED WITH, OR IN SOME WAY RELATED TO THE GENERAL ELECTRIC CO., APRIL, 1911—Continued.

Group B.—Commercial water-power companies of whose securities a portion, but less than a majority, is held by the "General Electric companies." In all cases there are common officers or directors.

Company.	Water power. Developed and under construction.	Water power. Undeveloped.	Water power. Total.	Per cent of securities held by the "General Electric companies."	Personal connection with the "General Electric companies," showing individual and position in water-power company.
	h. p.	h. p.	h. p.		
Butte Electric & Power Co.	69,260	97,600	166,860	Bonds, 6.1 [1]	C. A. Coffin, dir.; C. W. Wetmore, pres. and dir.; S. Z. Mitchell, vice pres. and dir.
Central Colorado Power Co.	39,000	50,000	89,000	Common stock, 11.5; preferred stock, 2.7; first mtg. bonds, 1.9.	S. Z. Mitchell, vice pres. and dir.; A. C. Bedford, dir.; A. E. Smith, asst. treas.
Northwestern Power Co.	.....	.....	.....	Common stock, 0.7; preferred stock, 1.2.	P. L. Saltonstall, dir.
Great Northern Power Co.	39,000	20,000	59,000	Bonds, 1.1	P. L. Saltonstall, dir.
Pennsylvania Water & Power Co.	135,000	.....	135,000	Common stock, 3.8; bonds, 5.8.	W. M. Barnum and A. C. Bedford, directors.
Sierra & San Francisco Power Co.	65,500	50,000	115,500	Bonds, 9.7 [1]	S. Z. Mitchell, dir.
San Juan Water & Power Co.	8,000	.....	8,000	Common stock, 8.7; bonds, 13.3.	F. L. Dame, pres. and dir.; A. E. Smith and S. Z. Mitchell, directors.
Western Power Co.	.....	.....	.....	Common stock, 0.2; preferred stock, 1.0.	A. W. Burchard and A. C. Bedford, directors.
Great Western Power Co.	60,000	300,000	360,000	Bonds, 1.9	A. C. Bedford, dir.
Whatcom County Railway & Light Co. [2]	3,300	5,000	8,300	Common stock, 6.7; bonds, 11.8.	C. N. Mason, dir.
Total	419,060	522,600	941,660		

Group C.—Commercial water-power companies in which one or more directors or officers are directors or officers in the "General Electric companies," but in which no securities are known to be corporately held.

Albany Southern R. R.	6,320	.....	6,320	.....	A. M. Young, 1st vice pres. and dir.
Colorado Springs Light, Heat & Power Co.	3,000	4,000	7,000	.....	S. R. Bertron, dir. [3]
Manchester Traction, Light & Power Co.	10,000	.....	10,000	.....	P. L. Saltonstall, dir.
Niagara Falls PowerCo.	[4] 118,300	.....	118,300	.....	E. T. Stotesbury, dir.

[1] Second mortgage bonds.

[2] Also included in Stone & Webster, Table 18, p. 164.

[3] Director of Susquehanna Railway, Light & Power Co., of which the Colorado Springs Light, Heat & Power Co. is a subsidiary.

[4] Does not include 62,500 h. p. developed on the Canadian side of Niagara Falls by an affiliated concern, the Canadian Niagara Power Co., but nearly all sold in the United States.

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TABLE 16.—COMPANIES OWNING OR CONTROLLING WATER POWER AND CONTROLLED BY, AFFILIATED WITH, OR IN SOME WAY RELATED TO THE GENERAL ELECTRIC CO., APRIL, 1911—Continued.

Group C.—Commercial water-power companies in which one or more directors or officers are directors or officers in the "General Electric companies," but in which no securities are known to be corporately held—Contd.

Company.	Water power.			Per cent of securities held by the "General Electric companies."	Personal connection with the "General Electric companies," showing individual and position in water-power company.
	Developed and under construction.	Undeveloped.	Total.		
	h. p.	h. p.	h. p.		
North American Co	1,750	4,500	6,250		C. A. Coffin, dir.
	[1] 8,000		8,000		C. W. Wetmore, dir.
	[2] [3] 60,000		60,000		Geo. R. Sheldon, treas. and dir.
Portland Railway, Light & Power Co.	48,000	75,000	123,000		A. C. Bedford and Frederick Strauss, directors.
Puget Sound Power Co.	[2] 20,000		20,000		S. Z. Mitchell.
Tampa Electric Co.	[2] 1,400		1,400		Robt. Treat Paine, 2d, dir.
Turners Falls Co.	9,425	6,000	15,425		Winthrop Coffin, dir.
Washington Water Power Co.	151,000	24,000	175,000		Hinsdill Parsons, dir.
Total	437,195	113,500	550,695		

[1] Bought from Southern Wisconsin Power Co.
[2] Also included in Stone & Webster group, Table 18, p. 164.
[3] Electrical horsepower delivered in St. Louis, under 99-year contract between a subsidiary and the Mississippi River Power Co.

Particular attention is directed to that column of the table which shows the personal connection of each water-power company with General Electric interests. The frequency with which some of these names occur has an obvious significance. Mr. Coffin is president of the General Electric Co.; Mr. Mitchell is president of the Electric Bond & Share Co., one of the most active and aggressive of the General Electric subsidiaries; and Mr. Bedford is a director in this company. Mr. Mason is vice president of the Electrical Securities Corporation. One prominent official of the Electric Bond & Share Co. insisted that his connections with water-power companies (which are extensive) are entirely personal and have no further significance. It is impossible, however, to conclude that the personal connection of prominent and active officers of the General Electric Co. and its subsidiaries has no broader significance.

It should be noted in connection with the companies shown in the table that some of them are also included in the group of companies operated by Stone & Webster. The inclusion of these companies with the General Electric group is warranted, however, by the fact

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that they fall within the classification that marks the evidence of General Electric influence. The companies included in both the General Electric and the Stone & Webster groups have 84,700 h. p. developed and under construction. The connection of Stone & Webster with General Electric interests is referred to elsewhere. (See p. 183.)

Referring again to Table 16 it will be seen that the water-power companies included in the three groups described (A, B, and C) own or control 1,580,715 h. p., of which 939,115 h. p. is developed or under construction. These figures do not include 62,500 h. p. developed by the Canadian Niagara Power Co. on the Canadian side at Niagara Falls, and 62,500 h. p. undeveloped and owned by the same company. While this power is subject to General Electric influence and is nearly all sold within the United States it has been omitted from the table because it is not generated in the United States.

The General Electric control of the power of the companies included in Group A is practically absolute. The extent of the influence of the General Electric Co. in the concerns included in Group B can not be precisely determined. It seems reasonable to infer, however, that where important General Electric men, such as prominent officers of the General Electric Co. or one of its subsidiaries, are found among the officers or on the directorate of the water-power company the influence must be considerable. On the other hand, the mere ownership of a small block of stock or a comparatively small amount of bonds and slight representation upon the board of directors may not indicate any considerable degree of influence. This second group represents nearly one-half of the developed water power in the General Electric group and more than four-fifths of the undeveloped power.

Group C, as shown in the table, includes water-power companies upon whose boards of directors or among whose officers are found men who occupy positions in the "General Electric companies," but none of whose securities, so far as is known to the Bureau, is corporately owned by them. That General Electric men are directors presumably means that they own stock. This does not necessarily mean affiliation with the General Electric Co., but it certainly tends to make an easy way for consolidation or close affiliation.

A brief analysis of the operations of the more important companies included in Table 16 reveals the fact that the activities of these water-power concerns are not always limited to the business of manufacturing and selling power. They involve the ownership and operation of municipal public-service utilities, thus broadening the influence of water power in its relations to the public and greatly widening and extending the influence of the owners of water power. A brief description of the more important companies in the respective groups follows:

GROUP A.—Six water-power companies, with a total of 82,860 h. p., developed and under construction, and 5,500 h. p., undeveloped, fall

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within this group. The total water power owned by some of the companies in this group is not large, yet its ownership is significant, because of the fact that subsidiary to at least two of these smaller concerns are all the public-service corporations of the principal cities in which they operate.

American Power & Light Co.—This company was incorporated in Maine in 1909 as an investment and holding company. It controls water power through the ownership of a majority of the stock of the Pacific Power & Light Co. While the General Electric companies do not own a majority of the stock of the American Power & Light Co., it is absolutely controlled by men prominently connected with these companies. These companies also own some securities in the Pacific Power & Light Co., which is practically operated by the officers of the Electric Bond & Share Co. F. G. Sykes, F. L. Dame, S. Z. Mitchell, A. C. Bedford, A. W. Burchard, E. W. Hill, F. A. Farrar, and A. M. Young, all of whom except the last are particularly prominent in General Electric affairs, are directors in the American Power & Light Co. F. G. Sykes is president and F. L. Dame and E. W. Hill are vice presidents. Furthermore, the outstanding common stock is in a voting trust consisting of S. Z. Mitchell, A. C. Bedford, and Starling W. Childs. Some of the above individuals appear as directors in the Pacific Power & Light Co. and other subsidiaries of the American Power & Light Co.

The American Power & Light Co. through the Pacific Power & Light Co. owns developed water power to the amount of 15,840 h. p. For details of the operations of the American Power & Light Co. and its subsidiaries see "Concentration in Washington," page 111.

Asheville Electric Co.—This company is a consolidation of the Asheville Street Railroad Co., the Asheville & Biltmore Street Railway & Transportation Co., the Intermontane Railroad Co., and the old Asheville Electric Co. All the bonds and practically all the stock of the Asheville Electric Co. are owned by the General Electric companies; and C. N. Mason, vice president of the Electrical Securities Corporation, is vice president and director.

The Asheville Electric Co. has water-power developments of its own of only 260 h. p. It secures most of its energy from the W. T. Weaver Power Co., a subsidiary of the North Carolina Electrical Power Co.[1] The Asheville company owns an undeveloped water-power site of at least 3,000 h. p. on the French Broad River 8 miles north of Asheville. It operates all the street railways and lighting plants in Asheville and vicinity.

Carolina Power & Light Co.—This company is a consolidation of the Raleigh Electric Co. and the street railways of Raleigh, N. C., the Central Carolina Power Co., and the Consumers Light & Power

[1] This company appears to be entirely independent.

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Co. of Sanford, N. C. It owns a gas plant at Durham, N. C., and recently it acquired all the stock of the Yadkin River Power Co. (formerly the Rockingham Power Co.). In the acquisition of the Yadkin River Power Co. the Carolina Power & Light Co. issued $3,300,000 of common stock for a like amount (the entire issue) of the stock of the Yadkin River Power Co. In this expansion the General Electric companies did not acquire a majority of the stock, but the Electric Bond & Share Co. operates the properties and General Electric interests still control them.

The water-power development of this company consists of an installation of 4,200 h. p. at Buckhorn Falls on the Cape Fear River near Moncure, 800 h. p. on the Neuse River near Raleigh, leased from the Raleigh Ice & Electric Co., and 32,000 h. p. being developed on the Yadkin River near Rockingham.

The company does the street railway and lighting business in Raleigh and supplies light to Sanford and Jonesboro, besides selling power to various manufacturing concerns. Its transmission lines extend to Fayetteville, where electricity is supplied for light and power. The transmission line is projected from the Yadkin River plant to Raleigh, a distance of about 100 miles. The new line will connect with the old line at Sanford.

Consolidated Power & Light Co. of South Dakota.—This company is a successor of the old Consolidated Power & Light Co. of South Dakota (a Wyoming corporation), which was a consolidation of the Black Hills Electric Light Co. and the Belt Light & Power Co. A majority of the securities of this company are held by "General Electric companies," though the names of General Electric men do not appear on its board of directors.

Its water power consists of 2,000 h. p. developed and 2,500 h. p. undeveloped. It supplies light and power to Deadwood and Lead, S. Dak.

Rockford Electric Co.—This is a subsidiary of the American Gas & Electric Co., a majority of whose stock is held by the Electric Bond & Share Co. (General Electric). The electric light and gas plants at Rockford, Ill., are owned by the Rockford Electric Co. Its water power consists of 1,760 developed horsepower.

Schenectady Power Co.—This was formerly the Schaghticoke Power Co. Its name was changed in 1908. Its water power consists of two developments, one of 6,000 h. p. at Johnsonville, and the other of 20,000 h. p. 5 miles below at Schaghticoke, both on the Hoosick River in the State of New York. The company is owned outright by the General Electric Co., and practically all its energy is used at the General Electric works at Schenectady.

GROUP B.—This group includes those water-power companies of whose securities a portion, but less than a majority, is held by the

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General Electric Co. or its subsidiaries, and among whose officers, or upon whose boards of directors, are found officers or directors of the "General Electric companies." The total water power controlled by this group is 419,060 h. p., developed and under construction, and 522,600 h. p., undeveloped.

Butte Electric & Power Co.—This company was incorporated in New Jersey in 1901. The General Electric companies own about 6 per cent of the second mortgage bonds of this company. The relationship is apparently mainly established through directors. C. A. Coffin, president of the General Electric Co., and S. Z. Mitchell, president, and C. W. Wetmore, a director in the Electric Bond & Share Co., are all directors in the Butte Electric & Power Co.

The Butte Electric & Power Co. and its constituent and subsidiary companies control 69,260 h. p. developed water power and 97,600 h. p. undeveloped. It is the dominant figure in the water-power situation in Montana. The details of its operations are discussed under "Concentration in Montana." (See p. 112.)

Central Colorado Power Co.—This company has 39,000 h. p. developed and 50,000 h. p. undeveloped and dominates the water-power situation in Colorado. It owns all the stock of the Leadville Light & Power Co. and has a working contract with the United Hydro-Electric Co. It is subject to strong General Electric influence and probably dominated thereby. The General Electric companies own some of the stocks and bonds, and S. Z. Mitchell, A. C. Bedford, and A. E. Smith are on its board of directors. S. Z. Mitchell is vice president of the company and A. E. Smith is assistant treasurer. For details of its operations see "Concentration in Colorado," page 114.

San Juan Water & Power Co.—This company operates in the vicinity of Durango, Colo. Nearly 9 per cent of its common stock and more than 13 per cent of its bonds are owned by the General Electric companies, and three prominent General Electric men are on its board of directors, one of whom is president. This company is practically, if not absolutely, controlled by the same interests (General Electric) that control the Central Colorado Power Co. (See p. 115.) It has 8,000 h. p. of developed water power. It owns the lighting plants in Durango and sells power in that vicinity.

Northwestern Power Co.—This company was incorporated in Maine in 1905. It operates in Duluth, Minn., and vicinity. It owns all the capital stock of the Great Northern Power Co. through which it controls its water power. While the corporate interest of the General Electric companies in the Northwestern Power Co. and its subsidiary is of itself insignificant, a relationship is suggested by the fact that the Duluth Edison Electric Co., which is closely affiliated with the General Electric, is the principal customer of the Great Northern

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and controls the markets of Duluth. Furthermore, P. L. Saltonstall, a director in the Electric Bond & Share Co., is a director in both these companies.

The Great Northern Power Co. owns water power to the amount of 39,000 h. p., developed and under construction, and 20,000 h. p., undeveloped. It owns the entire common stock of the Northern Power Co. of Wisconsin, through which it supplies electricity in Wisconsin. It has a franchise for 6 miles of underground conduit in the city of Duluth and owns in fee rights of way in that city for transmission lines to substations in Duluth and Superior. In the city of Superior its substation apparatus is installed in the plant of the Superior Water, Light & Power Co., to which it sells power.

Pennsylvania Water & Power Co.—This company is a reorganization of the McCall Ferry Power Co. A majority of the reorganization committee were General Electric men. The General Electric companies own a small portion of the stocks and bonds, and W. M. Barnum and A. C. Bedford, both General Electric men, are directors. Its water power is on the Susquehanna River in Pennsylvania, where it has developed and under construction 135,000 h. p. It sells 20,000 electrical horsepower to the Consolidated Gas, Electric Light & Power Co. of Baltimore, which controls the entire gas, electric light, and power business of that city.

Sierra & San Francisco Power Co.—The Sierra & San Francisco Power Co. is controlled by the United Railways Investment Co. of San Francisco. The General Electric companies together own nearly 10 per cent of the bonds of the Sierra & San Francisco Power Co., and S. Z. Mitchell, president of the Electric Bond & Share Co., one of the most active and influential of the men connected with the General Electric interests, is on its board of directors.

The Sierra & San Francisco Power Co. owns 65,500 h. p. of water power developed and under construction and 50,000 h. p. undeveloped. It also has steam plants with a rated capacity of 30,400 h. p. Nearly all its power is used by the parent company in the operation of its street railroads in San Francisco. It sells some power to the Pacific Gas & Electric Co., which, in turn, sells some power to a subsidiary of the United Railways Investment Co.

Western Power Co.—This company controls water power through its subsidiary, the Great Western Power Co. The security holdings of the General Electric companies in these concerns are not significant, but two prominent General Electric men, namely, A. W. Burchard and A. C. Bedford, are directors in the Western Power Co., and the latter is also a director in the Great Western Power Co.

This company controls water power to the amount of 60,000 h. p., developed and under construction, and 300,000 h. p., undeveloped. The relationship of this company to the Pacific Gas & Electric Co.

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and other details are discussed under "Concentration in California." (See p. 101.)

Whatcom County Railway & Light Co.—The General Electric companies own nearly 7 per cent of common stock and nearly 12 per cent of the bonds of this company, and C. N. Mason, who is vice president and director of the Electrical Securities Corporation, and a director in the United Electric Securities Co., is a director.

The company has water power to the amount of 3,300 h. p. developed, and 5,000 h. p. undeveloped. It does the entire electric railway, electric lighting, power, and gas business in Bellingham, Wash. It also owns the capital stock of the Bellingham & Skagit Railway Co. This company is also included in the Stone & Webster group. (See p. 164.)

GROUP C.—This group is composed of companies, each of which has at least one officer or director who is an officer or director of the "General Electric companies." It includes 10 companies with a total water power, developed and under construction, of 437,195 h. p., and 113,500 h. p., undeveloped. This does not include 62,500 h. p., developed, and 62,500 h. p., undeveloped, on the Canadian side of Niagara Falls.

Albany Southern Railroad.—This company was organized in New York as successor of the Albany & Hudson Railroad, which was itself successor to the Albany Hudson Railroad & Power Co. In the organization of the Albany Southern the Albany & Greenbush Bridge Co. was absorbed. A. M. Young, a director in the Electric Bond & Share Co., is a director and first vice president of this company.

The company has developed water power to the amount of 6,320 h. p. It operates an electric railroad from Hudson to Rensselaer, N. Y., a distance of 35 miles, together with local lines in Hudson. It leases traction rights from the United Traction Co.'s lines from Rensselaer to State Street, Albany. Altogether it operates 49 miles of track. It owns all the gas and electric light plants in Hudson and Rensselaer and supplies power to East Greenbush, Kinderhook, Nassau, Niverville, North Chatham, Stuyvesant Falls, and Valatie. J. G. White & Co. are the operating managers.

Colorado Springs Light, Heat & Power Co.—This company is controlled by the United Gas & Electric Co., which is a subsidiary of the Susquehanna Railway, Light & Power Co. The relationship of the Colorado Springs Light, Heat & Traction Co. to the General Electric Co. is through the last-named company, in which S. R. Bertron, a director of the Electric Bond & Share Co., is a director. The Colorado Springs Co. has water power to the amount of 3,000 h. p. developed, and 4,000 h. p. undeveloped. It controls the entire electric light and power business of Colorado Springs and Colorado City, Colo. It also does the electric light and power business of Manitou, Colo.

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Manchester Traction, Light & Power Co.—This company, or its subsidiaries, has four developed power sites with a total rated wheel capacity of 10,000 h. p. It owns the electric lighting plants of Manchester, N. H., and controls, through stock ownership, the Manchester Street Railway, the Manchester and Derry Street Railway, and the Manchester & Nashua Street Railway. These subsidiaries operate about 67 miles of street and interurban railways in Manchester and vicinity.

Niagara Falls Power Co.—This company was incorporated in 1886 in New York with authority to use the water of Niagara River and transmit energy developed thereby to points in New York State.

A direct relationship between the General Electric Co. and the Niagara Falls Power Co. is found in the fact that E. T. Stotesbury, of the firm of J. P. Morgan & Co., is a director in both concerns. Furthermore, that firm has two additional directors in the Niagara Falls Power Co. This is an indication of an important degree of common control, since the firm of J. P. Morgan & Co. is generally regarded as the dominating interest in the General Electric Co.

The wheel installation of this company is 111,000 h. p., and it sells 7,300 h. p. in the form of water, thus giving it a total of 118,300 h. p. The Niagara Falls Power Co. owns practically all the stock of the Canadian Niagara Power Co., which has 62,500 h. p. developed and 62,500 h. p. undeveloped on the Canadian side. The Niagara Falls Power Co., therefore, really controls 180,000 h. p. developed and under construction, but only that portion developed within the United States is included in the table.

The Niagara Falls Power Co. also owns more than half the stock of the Cataract Power & Conduit Co., and all the stock of the Tonawanda Power Co. These two latter companies distribute power, respectively, in Buffalo, and in Tonawanda and North Tonawanda, N. Y. These distributing subsidiaries furnish most of the power for the International Railway Co., which operates approximately 375 miles of track, including all the electric street railway systems of Buffalo, N. Y., and vicinity, besides suburban and interurban electric lines. They also supply current to the lighting companies of Buffalo, and light Tonawanda and North Tonawanda.

North American Co.—This company was incorporated in New Jersey in 1890. Evidence of close affiliation with General Electric interests is apparent. C. A. Coffin, president of the General Electric Co., and C. W. Wetmore, a director of the Electric Bond & Share Co., are directors in the North American Co., and George R. Sheldon, president and director of the Electrical Securities Corporation, is its treasurer.

The North American Co. was authorized to acquire the property of the Oregon & Transcontinental Co. and to engage in railroad and

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general financiering and to promote street railway, electric light, and power enterprises. This company is remarkable in the extent of its control of public-service corporations. It controls, through stock ownership, the Milwaukee Light, Heat & Traction Co., the United Railways Co. of St. Louis, the St. Louis County Gas Co., the Union Electric Light & Power Co. of St. Louis, the Suburban Electric Light & Power Co., the Detroit Edison Co., the Racine Gaslight Co., the West Kentucky Coal Co., and the Mississippi Power Distributing Co. It recently subscribed for $500,000 of the bonds and $200,000 of the common stock of the Mississippi River Power Co.

The North American Co. is not primarily a water-power corporation. It owns 1,750 h. p. through the Detroit Edison Co. It purchases 8,000 h. p. from the Southern Wisconsin Power Co., which is practically the entire output of that concern, and its subsidiary, the Mississippi Power Distributing Co., has a contract with the Mississippi River Power Co. for 60,000 electrical horsepower delivered in St. Louis. The company is thus placed in practical control of 69,750 h. p. It should be pointed out that the 60,000 h. p. involved in the contract with the Mississippi River Power Co. is electrical horsepower, and therefore is considerably less than the actual wheel power at the point of development.

The company through its subsidiaries does the entire commercial lighting business of Detroit, Mich., and lights not less than six smaller communities in that vicinity. Similarly, it operates practically all the public-service utilities (traction and electric light) in Milwaukee and St. Louis.

Portland Railway, Light & Power Co.—This company was organized in Oregon in 1906. At the time of its organization it purchased the property of the Portland Railway Co., the Portland General Electric Co., and the Oregon Water Power & Railway Co. The company owns or controls 48,000 h. p. developed and 75,000 h. p. undeveloped. Two of its directors are also directors in the General Electric companies. This company, however, is primarily a part of the Clark-Foote-Hodenpyl-Walbridge interests. (See p. 174.)

The Portland Railway, Light & Power Co. now owns practically the entire street railway and all the electric light and power plants in Portland, Oreg., the electric light and power plants in Oregon City, Silverton, Woodburn, and several other small towns in Oregon, and in Vancouver, Wash. It owns the street railway system and electric light and power, and gas plants of Salem, Oreg. Its railway mileage is equivalent to 251 single-track miles.

Puget Sound Power Co.—This company is a subsidiary of the Seattle Electric Co., which, in turn, is controlled by the Pacific Coast Power Co. S. Z. Mitchell, president of the Electric Bond & Share Co., is a director in the Puget Sound company. The Puget Sound Power Co.

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is also included in the Stone & Webster group (p. 164). It has water power developed and under construction to the amount of 20,000 h. p. Power developed by this company is distributed to Tacoma, Seattle, and intermediate points for railway, lighting, and manufacturing purposes. For details of its operation see "Concentration in Washington," page 107.

Tampa Electric Co.—This is another company that is also included in the Stone & Webster group. Robert Treat Paine, 2d, who is a director in the General Electric Co., the Electric Bond & Share Co., and the United Electric Securities Co., is vice president and director in this company. It has developed water power to the amount of 1,400 h. p. It operates in Tampa, Fla., and vicinity. For details see page 166.

Turners Falls Co.—This company has water rights on the Connecticut River at Turners Falls, Mass. Its primary business is to sell power in the form of water. It thus sells 6,425 h. p. to various users who have their own installations. The surplus water, after supplying others, is used by the company itself in the operation of a hydroelectric plant with a rated wheel capacity of 3,000 h. p. The total wheel installation in connection with its property is, therefore, 9,425 h. p.

Most of the power generated by its own wheels is sold to the Greenfield Electric Light & Power Co. at Greenfield and the Franklin Electric Light Co. at Amherst; the remainder is used for lighting Turners Falls.

Washington Water Power Co.—Hinsdill Parsons, who is a vice president of the General Electric Co. and director in the Electric Bond & Share Co., is a director in this company.

The Washington Water Power Co. operates in the vicinity of Spokane, Wash., and practically dominates the power situation in that region. It has power to the amount of 151,000 h. p., developed and under construction, and 24,000 h. p., undeveloped. The operations of this company are discussed in more detail under "Concentration in Washington." (See p. 110.)

MAGNITUDE OF GENERAL ELECTRIC INFLUENCE IN WATER-POWER DEVELOPMENT.—It should be kept in mind that the General Electric interests do not absolutely control all the power embraced in this discussion. As previously stated, there is no way of knowing the extent of the influence exercised in some of the companies. It is entirely reasonable to assume, however, that whenever an officer or director of one of the General Electric companies is a director or officer of a water-power company he exercises some influence, and that such influence is certainly friendly to General Electric interests. In Group C, it will be recalled that neither the General Electric Co. nor its subsidiaries (the "General Electric companies") own any

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of the securities and that the influence of the General Electric Co. is due entirely to representation on boards of directors. In Group B, the General Electric influence may be somewhat stronger by virtue of the ownership of securities. In Group A the General Electric has practically complete control by virtue of security ownership as well as representation on boards of directors. That the presence of officers or directors of General Electric interests on the directorates of water-power companies does carry with it considerable influence can not be reasonably questioned. In discussing, therefore, the influence of the General Electric Co. in water-power development all those companies are included in which it is reasonably certain that some such influence is exercised, although this is obviously, to some extent, a matter of opinion.

The importance of the water power, subject to some sort of influence from the General Electric Co. and its subsidiaries, does not fully appear from the figures given in Table 16 and the discussion in connection with it. Table 7 [1] shows the total commercial power developed and under construction in the United States to be 2,961,549 h. p. The total water power developed and under construction, owned or controlled by companies subject to a greater or less degree of General Electric influence, as shown in Table 16, is here summarized as follows:

	Horsepower.
Group A	82,860
Group B	419,060
Group C	437,195
Total	939,115

The above total of 939,115 h. p. represents more than 31 per cent of all the commercial water power, developed and under construction, in the United States. These figures, however, do not include the 62,500 h. p. developed by the Canadian Niagara Power Co. on the Canadian side at Niagara Falls, practically all sold in the United States, and subject to the same degree of General Electric influence as the power included in Group C of Table 16.

Opposite page 158 is a map showing the sites of commercial power developed and under construction in the United States. The power subject to the influence of certain specified large interests is distinguished on this map by colors and symbols. The red squares on the map indicate the power in the General Electric group as shown in Table 16. From an inspection of the map it is readily seen that the General Electric group of hydroelectric concerns reaches into practically every section of the country where there is any commercially developed water power of importance.

The total commercial water power developed and under construction in the States in which are found one or more companies of the General Electric group, and the volume of power developed or under

[1] See p. 62.

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construction, owned or controlled by companies included in the General Electric group, are shown in the following table:

TABLE 17.—COMMERCIAL WATER POWER, DEVELOPED AND UNDER CONSTRUCTION, IN STATES INVOLVED IN THE GENERAL ELECTRIC GROUP, THE AMOUNT OF POWER IN THE GENERAL ELECTRIC GROUP, AND ITS PERCENTAGE OF THE TOTAL IN THESE STATES.

States.	Total commercial power developed and under construction (horsepower).	Total power, General Electric group.	
		Horsepower.	Per cent of total.
Total	2,325,757	939,115	40.4
California	429,467	125,500	29.2
Colorado	69,690	50,000	71.7
Florida	5,000	1,400	28.0
Idaho	52,100	18,000	34.5
Illinois	38,460	1,760	4.6
Iowa	151,400	[1]60,000	39.6
Massachusetts	76,697	9,425	12.3
Michigan	102,682	1,750	1.7
Minnesota	95,815	39,000	40.7
Montana	139,260	69,260	49.7
New Hampshire	16,450	10,000	60.8
New York	398,058	[2]150,620	37.8
North Carolina	82,960	37,260	44.9
Oregon	95,777	55,760	58.2
Pennsylvania	169,632	135,000	79.6
South Dakota	5,000	2,000	40.0
Washington	300,510	164,380	54.7
Wisconsin	96,799	8,000	8.3

[1] At p. 147 it will be seen that the volume of power credited to the General Electric group in Iowa is the quantity delivered in St. Louis and is, therefore, undoubtedly too low as compared with other water-power figures. The wheel capacity necessary to generate this 60,000 h. p. greatly exceeds the quantity delivered in St. Louis.

[2] Includes 26,000 h. p. used in General Electric works at Schenectady.

From this table it is seen that the water-power companies in the General Electric group are found in 18 States. These 18 States have 2,325,757 commercial horsepower developed or under construction, and of this total the General Electric group includes 939,115 h. p., or 40.4 per cent. The greatest amount of power controlled by companies in the General Electric group in any State is found in Washington. This is followed by New York, Pennsylvania, California, Montana, Iowa, Oregon, and Colorado. In five of the States shown in the table the water-power companies included in the General Electric group control more than 50 per cent of the commercial power, developed and under construction. The percentage of power in the States included in the General Electric group ranges from a little less than 2 per cent in Michigan to nearly 80 per cent in Pennsylvania. In Colorado they control 72 per cent; in New

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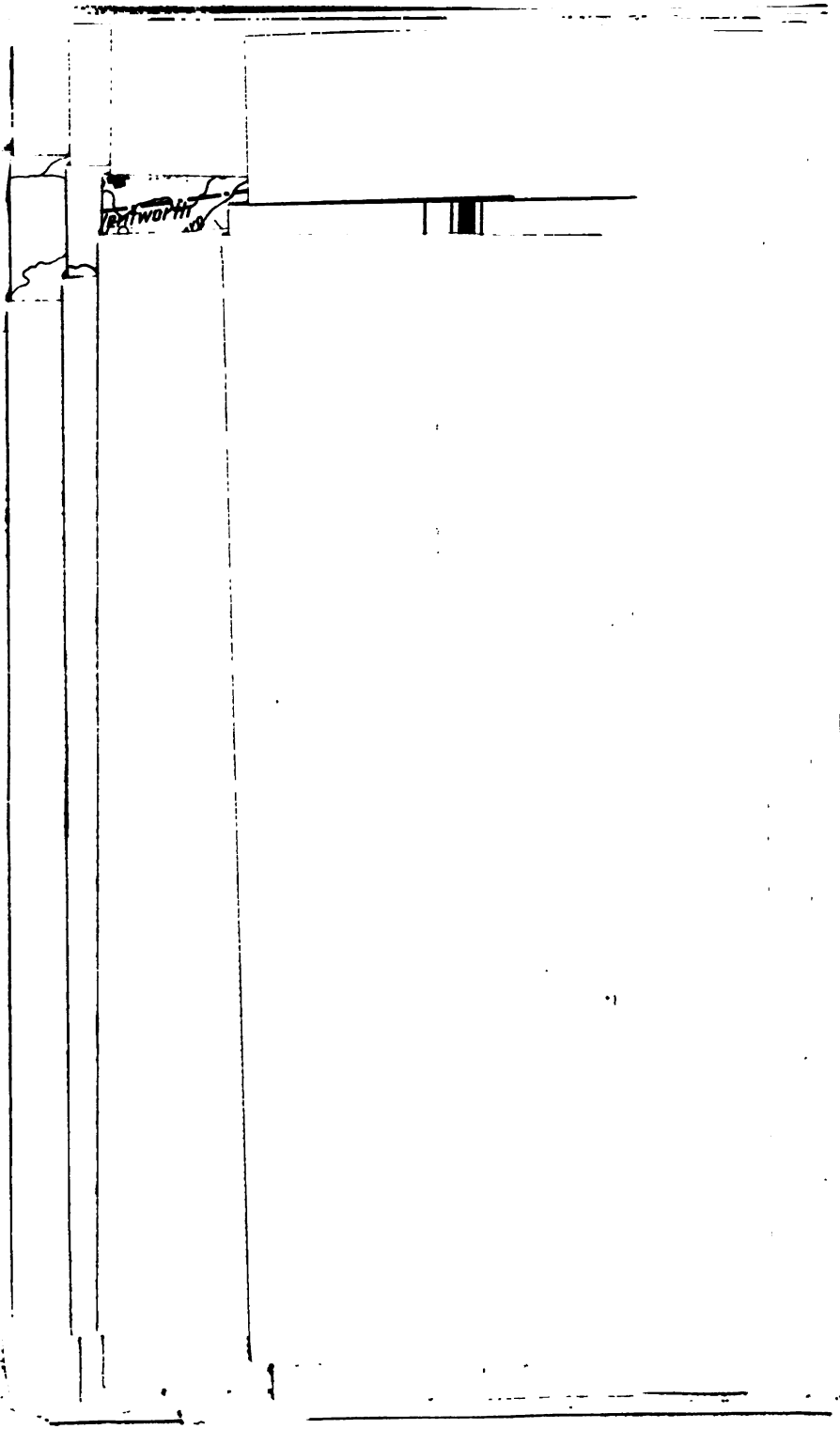

[1] See p. 186.

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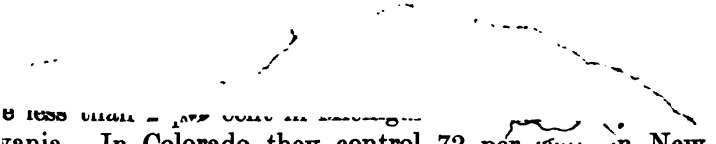

vania. In Colorado they control 72 per cent, in New

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Hampshire 61 per cent; in Oregon 58 per cent; and in Washington 55 per cent.

Besides the power developed and under construction included in Table 17, the water-power concerns included in the General Electric group own in the States shown in the table 641,600 h. p., undeveloped. This does not include 20,000 undeveloped horsepower in the State of Alabama, in which State, so far as is known, there is no developed power subject to General Electric influence, nor 62,500 h. p., undeveloped, on the Canadian side of Niagara Falls. The undeveloped water power, however, credited to the General Electric group probably does not represent all of such power in that group. But at least 1,580,715 h. p., developed, under construction and undeveloped, falls within the General Electric group, not including 82,500 h. p., undeveloped, in Alabama and Canada. The developed power in this group, with the exception of 26,000 h. p., is practically all commercial power; that is, power that is produced for sale or produced by public-service corporations. The 26,000 h. p. used in manufacturing is owned absolutely by the General Electric Co. and used almost entirely in the operation of its manufacturing plants at Schenectady, N. Y. These figures for the General Electric group take a much higher significance in the light of the fact that often these developments represent the best (and in some instances practically all) of the water power in those communities where they are located, and the further fact that the companies that control the water power also own or control the municipal public-service corporations in the principal cities and towns served with power.

RELATION OF GENERAL ELECTRIC CO. TO MUNICIPAL PUBLIC-SERVICE CORPORATIONS.—The natural tendency of water-power companies and municipal public-service corporations to affiliate is discussed hereafter.[1] It is there shown that this affiliation has grown wider and stronger, until at present the street railways and electric-light and gas plants in hundreds of cities and towns are actually controlled by water-power concerns, and that many other such corporations are closely affiliated with water-power companies. This significant condition is well illustrated in the General Electric group.

The water-power companies subject to General Electric influence control the street railways in at least 16 cities and towns, the electric light plants in 78 cities and towns, gas plants in 19 cities and towns, and are affiliated with the electric-light and gas plants in other towns. Though many of these communities, particularly those served with light only, are small, several of them are the most important in the States where these water-power companies operate. The water-power companies in the General Electric group own, control, or are

[1] See p. 186.

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closely affiliated with, the street railways in Portland and Salem, Oreg.; Spokane, Wash.; Great Falls, Mont.; St. Louis, Mo.; Winona, Minn.; Milwaukee and Racine, Wis.; Elmira, N. Y.; Asheville and Raleigh, N. C., and other relatively less important towns. The towns in which the lighting plants (electric or gas) are owned or controlled include Portland, Salem, Astoria, and other towns in Oregon; Bellingham and other towns in Washington; Butte, Great Falls, Bozeman and other towns in Montana; Leadville and Colorado Springs in Colorado; St. Louis, Mo.; Milwaukee, Racine and several small towns in Wisconsin; Hudson and Rennselaer, N. Y.; Detroit, Mich.; Asheville and Raleigh, N. C.; and in fact one or more towns in practically every community where developed water power is controlled by this group. In addition to the public-service corporations thus controlled by the water-power companies subject to General Electric influence, there are numerous public-service corporations in other municipalities that purchase power from the hydroelectric developments controlled by or affiliated with the General Electric Co. This is true of Denver, Colo., which has already been discussed.[1] In Baltimore, Md., a water-power concern in the General Electric group, namely, the Pennsylvania Water & Power Co., sells 20,000 h. p. to the Consolidated Gas, Electric Light & Power Co., which controls the entire light and power business of that city. The power to operate all the electric street railway systems of Buffalo, N. Y., and vicinity, involving a trackage of approximately 375 miles, is supplied through a subsidiary of the Niagara Falls Power Co.

The influence of the General Electric Co. in municipal public-service corporations is not by any means confined to those communities that have water power. It, or its subsidiaries, has acquired control of or an interest in the public-service corporations of numerous cities where there is no water-power connection, and it is affiliated with still others by virtue of common directors. Perhaps the chief significance of the wide General Electric influence in municipal public-service corporations that have no connection with water power, lies in the fact that it emphasizes the tendency of large interests not only to acquire the water powers in various sections, but at the same time to acquire control of those public-service corporations that are naturally the best customers for water power. Broadly speaking, hydroelectric developments, electric railways, and electric-lighting plants fall within that group of enterprises commonly known as the electrical industries, and quite naturally an interest in one branch involves an interest in other branches.

Some of the largest municipal public-service corporations in the country are subject to General Electric control or influence. The American Gas & Electric Co. is one of the most prominent examples. It is controlled by the General Electric Co. through the ownership

[1] See p. 117.

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of a majority of its stock by the Electric Bond & Share Co. The American Gas & Electric group of concerns includes 13 lighting corporations operating in 7 States. This company controls the electric-light or gas plants, or both, in Ashland, Canton, and Bridgeport, Ohio; Atlantic City, N. J.; Auburn, N. Y.; Wheeling, W. Va. Muncie, Ind.; Rockford, Ill.; and Scranton, Pa.; and one of its subsidiaries, the Rockford Electric Co., owns a hydroelectric plant with 1,760 h. p. at Rockford, Ill.

A majority of the stock of the Omaha Electric Light & Power Co., which controls the lighting of Omaha, Nebr., and Council Bluffs, Iowa, is owned by the Electric Bond & Share Co. and the Electrical Securities Corporation. The Buffalo & Lake Erie Traction Co., which controls the electric railway from Buffalo, N. Y., to Erie, Pa., and the street railways of Dunkirk, N. Y., and Erie, Pa., has upon its board of directors S. Z. Mitchell, who is president of the Electric Bond & Share Co., and S. R. Bertron, who is a director in that company. Other municipal public-service corporations more or less subject to General Electric influence, through common directors, are the Federal Light & Traction Co., with 14 subsidiaries, Chattanooga Electric Co., Massachusetts Electric Co., Massachusetts Gas Co., Puget Sound Electric Railway, and the Helena (Mont.) Light & Railway Co.

The influence of the General Electric Co. in municipal public-service corporations extends into practically every section of the United States.

This vast network of relationship between hydroelectric corporations and municipal public-service corporations through prominent officers and directors of the largest manufacturer of electrical machinery and supplies in the United States is highly significant.

STRONG FINANCIAL POSITION OF THE GENERAL ELECTRIC CO.—The officers and directors of the General Electric companies are also officers or directors in more than 50 banking and trust companies, many of which are among the strongest in the country.

Probably at the head of this list of financial institutions should be placed J. P. Morgan & Co. and the Morgan banking interests. These interests include, among others, J. P. Morgan & Co.; First National Bank, New York; National Bank of Commerce, New York; Standard Trust Co., of New York; Drexel & Co., Philadelphia; Franklin National Bank, Philadelphia; and the Girard Trust Co., of Philadelphia. Other powerful financial institutions with General Electric connections are the Trust Co. of America; Knickerbocker Trust Co.; New York Trust Co.; Bay State Trust Co. of Boston; Commonwealth Trust Co., Boston; Old Colony Trust Co., Boston; Metropolitan Trust Co., New York; First Trust & Savings Bank, Chicago; and there are numerous others. The relationship undoubtedly gives the General Electric Co. a powerful advantage in all its financial operations.

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Of course the officers and directors of the General Electric Co. or its subsidiaries do not control all these banks and trust companies. But the connection with such influential persons in banking circles as J. P. Morgan, Charles Steele, E. T. Stotesbury—the last two partners of Mr. Morgan—and George R. Sheldon (all directors in the General Electric Co. or some one of its subsidiaries), together with other powerful banking connections, undoubtedly places the General Electric group in a very advantageous position with respect to commanding capital for the floating of securities. The enormous cost of the development of a water-power enterprise has already been alluded to. The terms upon which a development can be financed may often determine whether the development shall be made at all or not. The advantage, therefore, of having the favor of a number of the largest financial institutions is apparent.

A list of the banking institutions with the number of directors common to each bank and to the "General Electric companies" is presented herewith:

Name and location.	Directors.	Name and location.	Directors.
Old Colony Trust Co., Boston	8	Windsor Trust Co., New York	1
Bay State Trust Co., Boston	6	Mercantile National Bank, New York	1
American Trust Co., Boston	4	Securities Co., New York	1
Provident Institute for Savings, Boston	4	W. C. Sheldon & Co., New York	1
Standard Trust Co., New York	3	American Exchange National Bank, New York	1
J. P. Morgan & Co., New York	3	National Surety Co., New York	1
National Shawmut Bank, Boston	2	New York Trust Co., New York	1
National Bank of Commerce, Boston	2	Mechanics and Metals National Bank, New York	1
Suffolk Savings Bank for Seamen, Boston	2	National Bank of Commerce, New York	1
French Finance Corporation of America, New York	2	U. S. Mortgage & Trust Co., New York	1
Schenectady Trust Co., Schenectady, N. Y.	2	Union Dime Savings Bank, New York	1
Harvey Fisk & Sons, New York	2	Knauth, Nachod & Kuhne, New York	1
First Trust & Savings Bank, Chicago	2	Hayden, Stone & Co., New York	1
First National Bank, Chicago	2	Jackson & Curtis, New York	1
Commonwealth Trust Co., Boston	1	Bertron, Griscom & Jenks, New York and Philadelphia	1
First National Bank, Boston	1	First National Bank, New York	1
State National Bank, Boston	1	Philadelphia Trust, Safe Deposit and Insurance Co., Philadelphia	1
Lee, Higginson & Co., Boston and New York	1	Franklin National Bank, Philadelphia	1
Boston Five Cent Savings Bank, Boston	1	Drexel & Co., Philadelphia	1
Boston Safe Deposit & Trust Co., Boston	1	Philadelphia National Bank, Philadelphia	1
New England Trust Co., Boston	1	Girard Trust Co., Philadelphia	1
National Union Bank, Boston	1	Providence Banking Co., Providence, R. I.	1
Perry, Coffin & Burr, Boston	1	Mechanics Trust Co., Bayonne, N. J.	1
Knickerbocker Trust Co., New York	1	Commercial Trust Co. of New Jersey, Jersey City	1
Metropolitan Trust Co., New York	1	Union Savings Bank & Trust Co., Cincinnati	1
Manhattan Trust Co., New York	1		
Trust Company of America, New York	1		

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It is possible that this relationship to such a large number of strong financial concerns, through common officers and directors, affords the General Electric Co. an advantage that may place rivals at a corresponding disadvantage. Whether or not this great financial power has been used to the particular disadvantage of any rival water-power concern is not so important as the fact that such power exists and that it might be so used at any time. The tendency toward concentration in every field of enterprise is notorious; the evidence of closer relationship between public-service and industrial corporations on the one hand, and banking institutions on the other hand, is seen everywhere. The existence of such close relationship between finance and industry and a great natural resource is particularly significant.

Section 3. Stone & Webster group.

THE STONE & WEBSTER ORGANIZATION.—This organization consists primarily of the partnership of Stone & Webster. This partnership owns the Stone & Webster Engineering Corporation and the Stone & Webster Management Association. It also controls the Public Service Investment Co. The firm of Stone & Webster consists of five members who are active in the affairs of the various Stone & Webster corporations.

The Stone & Webster Engineering Corporation acts primarily as constructing engineers. It designs and builds railways, water-power developments, and lighting and power plants complete.

The Stone & Webster Management Association manages or operates municipal public-service corporations of practically every character and in every section of the country. The Stone & Webster interests do not necessarily own a majority of the stock in the companies which they operate and, in fact, they operate a number of corporations in which they have but slight, if any, financial interest. The fact of this management, however, does make Stone & Webster an important factor in the control of these corporations regardless of the amount of their securities owned.

The Public Service Investment Co. is a corporation organized for the purpose of holding and dealing in stocks, bonds, and other securities. As a rule, these securities are not held for investment nor for the purpose of controlling the corporation that issued them. It holds considerable blocks of the securities of water-power, electric-light, and street-railway companies, but the volume of these holdings is constantly changing.

Stone & Webster are also interested in the Railway & Light Securities Co., a corporation organized for the purpose of holding the securities of transportation, illuminating, power, and other public-service corporations for income or sale. This company issues collateral trust bonds secured by bonds of other corporations in the

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same manner as the United Electric Securities Co.[1] One member of the firm of Stone & Webster is president of the company, and three other members are directors. A director of the General Electric Co. is also found on its directorate.

WATER-POWER INTERESTS OF THE STONE & WEBSTER GROUP.—As already stated, the direct activities of Stone & Webster in the public-service field, including water power, are carried on through the Stone & Webster Management Association. According to information published by the firm of Stone & Webster, this association manages 38 corporations. Some of these are subsidiary to corporations that are not managed by the Stone & Webster Management Association. One of those in the published list is in Nova Scotia and one in Porto Rico, leaving 36 under this management in the United States. There are more than 20 other corporations subsidiary to those managed by Stone & Webster Management Association, thus placing directly and indirectly under this management between 55 and 60 corporations in this country. The function of a few of the main corporations under this management appears to be to hold the securities of subsidiaries through which actual operations are conducted. Eight of the companies managed by the Stone & Webster Management Association own developed water power. The amount of power owned by each is shown in the following table:

TABLE 18.—WATER POWER, DEVELOPED AND UNDEVELOPED, OPERATED BY COMPANIES MANAGED BY THE STONE & WEBSTER MANAGEMENT ASSOCIATION.

Company.	Developed.	Undeveloped.	Total.
	h. p.	h. p.	h. p.
Mississippi River Power Co.	150,000	150,000	300,000
Pacific Coast Power Co.[1]	77,000	53,000	130,000
Minneapolis General Electric Co.	18,750	76,250	95,000
Sierra Pacific Electric Co.	14,200	24,000	38,200
Columbus (Ga.) Power Co.	11,500	63,500	75,000
Whatcom County Railway & Light Co.	3,300	5,000	8,300
Blackstone Valley Gas & Electric Co.[2]	1,917	600	2,517
Tampa Electric Co.	1,400	.....	1,400
Total.	278,067	372,350	650,417

[1] Includes power of Puget Sound Power Co. and Seattle-Tacoma Power Co., subsidiaries of Pacific Coast Power Co.

[2] Water power owned by subsidiaries; company is primarily engaged in the gas business and in the operation of electric lighting and steam plants.

From the above table it will be seen that these companies together own developed water power to the amount of 278,067 h. p., as measured by wheel installation, and 372,350 h. p. undeveloped, or a total of 650,417 h. p. They also own steam generating plants with a rated capacity of 55,200 h. p.

[1] See p. 141.

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By far the largest development in the Stone & Webster group is that of the Mississippi River Power Co. on the Mississippi River at Keokuk, Iowa. This plant is now in process of construction, and it is estimated that it will be delivering power in St. Louis early in 1913. This company has a contract with the Mississippi River Power Distributing Co., a subsidiary of the North American Co., to deliver a maximum of 60,000 h. p. in the city of St. Louis.

The next largest volume of power under the Stone & Webster management is that belonging to the Pacific Coast Power Co. in the western part of the State of Washington. The Pacific Coast Power Co. and its subsidiaries, the Puget Sound Power Co. and the Seattle-Tacoma Power Co., own 77,000 h. p., developed and under construction, and 53,000 h. p. undeveloped. The Whatcom County Railway & Light Co., with 3,300 developed and 5,000 undeveloped horsepower, operates in the same general region as the Pacific Coast Power Co. All the companies together managed by Stone & Webster in this region have developed and under construction a total horsepower of 80,300 and 58,000 undeveloped. The holdings of these companies represent 60 per cent of all the developed water power in the Puget Sound region.

The Minneapolis General Electric Co., with 18,750 h. p. developed and 76,250 h. p. undeveloped, operates in Minneapolis, Minn., and vicinity.

The Sierra Pacific Electric Co. has 14,200 developed horsepower and 24,000 undeveloped. It operates in Nevada and owns the Reno Power, Light & Water Co., the Washoe County Power & Development Co., the Hunter Creek Water Co., the Sparks Water Co., the Carson City Coal Gas Co., and the Truckee River General Electric Co., with its subsidiary, the Carson Electric Light Co. The Sierra Pacific Electric Co. dominates the power situation in a large section of the western part of Nevada. Its transmission lines extend to Reno, Virginia City, Carson City, and as far south as Minden, and eastward to the mining district of Yerrington. Its service thus extends to the principal towns and to the important copper and gold mining districts in western Nevada.

The Columbus Power Co. is a subsidiary of the Columbus Electric Co., and controls all the commercial water power at Columbus, Ga., consisting of 11,500 developed and 63,500 undeveloped horsepower. It absolutely dominates the water-power situation at Columbus and vicinity.

The Whatcom County Railway & Light Co., the Tampa Electric Co., and the Puget Sound Power Co., included in the Stone & Webster group, are also included under the "General Electric companies" because General Electric interests own some of the securities of one of

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them and have directors in the other two. The Mississippi River Power Co., which is also under the Stone & Webster management, will sell 60,000 electrical h. p. to a subsidiary of the North American Co.; this power is likewise included in the General Electric group because of the relationship between the North American Co. and General Electric interests. These facts suggest an affiliation between the "General Electric companies" and Stone & Webster interests.

MUNICIPAL PUBLIC-SERVICE CORPORATIONS CONTROLLED BY WATER-POWER COMPANIES UNDER THE STONE & WEBSTER MANAGEMENT ASSOCIATION.—The water-power companies in the Stone & Webster group own or control and operate the street railways of 5 cities and towns, electric-lighting plants in 25 cities and towns, and gas plants in 4 cities and towns. Important instances are as follows: All the electric-railway, electric-light, and gas business of Columbus, Ga., and vicinity is done by the Columbus Electric Co. and its subsidiaries. All the electric lighting of Minneapolis, Minn.; Taylors Falls, Minn.; and St. Croix Falls, Wis., is done by the Minneapolis General Electric Co. The Tampa Electric Co. does all the electric railway and lighting business in Tampa, Fla., and operates an interurban line between Tampa and Port Tampa. The Seattle-Tacoma Power Co. does the general lighting business in Seattle, Tacoma, Everett, and other points in the State of Washington. The Whatcom County Railway & Light Co. does the entire electric-railway, electric-lighting, and gas business of Bellingham, Wash.

The Sierra Pacific Electric Co. owns the capital stock of the companies that do the entire electric lighting and power business in Reno, Sparks, Virginia City, Carson City, and Silver City, Nev. They also do the gas business in Reno, Sparks, and Carson City, and supply water for domestic purposes in Reno and Sparks.

RELATION OF STONE & WEBSTER TO OTHER MUNICIPAL PUBLIC-SERVICE CORPORATIONS.—As in the case of the General Electric Co., the activities of Stone & Webster are by no means confined to water-power developments and public-service corporations controlled through water-power corporations. The Stone & Webster Management Association manages 22 public-service corporations that do not own water power. These activities embrace cities and towns in the States of Massachusetts, Rhode Island, Kentucky, Georgia, Florida, Louisiana, Texas, and Michigan. These properties include 18 electric railways, 42 electric-light distributing plants, and several gas plants.

Probably the two most important groups of public-service corporations under this management are the combined operations in Dallas and Fort Worth, Tex., and in Galveston and Houston, Tex. The Dallas-Fort Worth group includes the operation of the street railways in Dallas and Fort Worth and an interurban line between these two cities. It also includes all the electric-lighting business of Dallas.

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The Galveston-Houston group includes the operation of all the street railways in Galveston and Houston and a portion of the electric-lighting business in Galveston. There is also under construction an interurban line between these two cities.

Besides the two groups in Texas above alluded to, this association manages the street railways of El Paso, Tex., and an interurban line from El Paso to Juarez, Mexico, and does all the lighting business in El Paso. It does all the electric-lighting business in Houghton and Keweenaw Counties, Mich. It does the entire electric-railway and a portion of the electric-light business in Jacksonville, Fla. It does all the street-railway and electric-light business in Key West, Fla. It does the entire electric-railway business and electric light and power business in Pensacola. It does the street-railway and gas and commercial electric-lighting business in Paducah, Ky., and all the electric-railway and the greater part of the electric-lighting business in Savannah, Ga.

In Massachusetts, electric street-railway and interurban business is conducted at Canton, Mattapan, Brockton, Plymouth, and other towns. The electric-light and gas business is done in Abington, Rockland, Cohasset, Fall River, Brockton, Whitman, Bridgewater, Stoughton, Lowell, and other towns.

In Rhode Island this management controls the entire gas and electric lighting business of the Blackstone Valley through the Blackstone Valley Gas & Electric Co.

In the Puget Sound region, where, as already noted, large water-power concerns are managed by the Stone & Webster Management Association, there are also under this management public-service corporations that do not own water power. It operates an interurban railway between Seattle and Tacoma and does the entire electric-railway business in Tacoma. It does the greater part of the street-railway and electric-light business in Seattle; operates an interurban line between Seattle and Everett; operates the street-railway system in Everett and Lowell and an interurban line between Everett and Snohomish, besides doing electric-lighting business in the last three towns and elsewhere.[1]

Section 4. Smith interests.

The group of companies under this head are usually considered as associated with S. Morgan Smith Co., of York, Pa. As a matter of fact, the S. Morgan Smith Co. has no corporate connection with any water-power company, except that it owns a small block of the securities of the Savannah River Power Co. The company is a manufacturer of water wheels, power-transmission machinery, and boiler and

[1] The public-service corporations here named as operating in the State of Washington are controlled by or affiliated with the Pacific Coast Power Co., which also controls the Puget Sound Power Co., heretofore mentioned.

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flume work. C. Elmer Smith, its active head, however, personally has large water-power interests. He is the controlling factor in two large power developments in Georgia, and he is interested in others that he does not absolutely control.

WATER POWERS IN THE SMITH GROUP.—The water powers in this group may be divided into two classes: (1) Companies controlled, and (2) companies upon whose boards of directors there is Smith representation, but which apparently are not controlled.

The companies in the first class and the water power owned by them are shown in the following statement:

Company.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Georgia Power Co.	53,250	80,000
Atlanta Water & Electric Power Co.	16,800	.....
Total.	70,050	80,000

The companies in the second class, with their water power, are as follows:

Company.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Albany Power & Manufacturing Co.	3,500	16,000
Savannah River Power Co.	3,000	.....
Total.	6,500	16,000

C. Elmer Smith and his brother control 25 per cent of the stock of the Albany Power & Manufacturing Co. The development of the Savannah River Power Co. is on the Savannah River west of Abbeville, S. C. The officers of the Savannah River Power Co. are substantially the same as those of the Anderson Water, Light & Power Co., which has a development of 7,600 h. p. on the Seneca River in South Carolina. The Anderson Water, Light & Power Co. has not been included in the above list for the reason that no member of the S. Morgan Smith Co. appears on the directorate. On account of its close relation to the Savannah River Power Co., however, it probably is more or less subject to Smith influence.

The Georgia Power Co. and the Atlanta Water & Electric Power Co., as already shown, occupy a very strong position in the power situation in Georgia. The power developed and under construction and that undeveloped, owned by these two companies, is together estimated at 150,000 h. p., all of which is tributary to the city of Atlanta and

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a number of other manufacturing towns in the section of the State that has probably the highest industrial development.

Section 5. Water-power properties of other large holders.

Besides the owners of large power developments already discussed in this chapter and the preceding one, there are a number of other owners whose holdings are of particular significance, both on account of the volume of power owned and because of the character of the owners.

WESTINGHOUSE INTERESTS.—The group of concerns commonly distinguished by the name "Westinghouse" embraces about 20 corporations in the United States and several abroad, engaged in the manufacture or sale of steam and electric machinery, a wide variety of electrical appliances, and various brake and coupling devices for locomotives and steam-railroad cars. That division of the Westinghouse group that is engaged in the manufacture of steam-railroad appliances and other products not closely related to the electrical industries need not be considered in this report. The production of electrical machinery and equipment has brought the Westinghouse interests into more or less close relation with water-power development. The water-power interests of this group are of comparatively minor importance.

The Westinghouse organization.—The Westinghouse concerns that are engaged in the manufacture and sale of electrical machinery and supplies all center around the Westinghouse Electric & Manufacturing Co. This company was incorporated in Pennsylvania in 1872. In 1890 it took over the business of the Westinghouse Electric Co., which was capitalized for $5,000,000. The personnel and organization of the new concern were practically the same as the old Westinghouse Electric Co., with George H. Westinghouse at its head.

This company manufactures and sells machinery and appliances for the generation, transmission, and utilization of electricity. The growth of its business is partly indicated by the fact that its security issues have increased from about $9,000,000 in 1894 to about $73,000,000 in 1910. The total gross assets of the company have increased in the same time from $14,700,000 to $83,600,000.

Westinghouse water-power interests.—It is probable that the Westinghouse interests do not control absolutely any water-power development. They do, however, have such relation to certain water-power concerns as will reasonably bring them within the scope of this discussion. George C. Smith, an active figure in water-power development, is a director in Westinghouse, Church, Kerr & Co., in the Electric Properties Co. (Westinghouse) and the Westinghouse Air Brake Co. A. N. Brady, who is a director of the Westinghouse Electric & Manufacturing Co., controls large water powers. The water-power

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companies that have some sort of connection with the Westinghouse interests are as follows: (1) The Ontario Power Co. of Niagara Falls, through the Niagara, Lockport & Ontario Power Co., which is controlled by the Westinghouse Electric & Manufacturing Co. and one of its subsidiaries, the Security Investment Co.; (2) the Atlanta Water & Electric Power Co.; (3) the Chattanooga & Tennessee River Power Co. and the Utica Gas & Electric Co.

Niagara, Lockport & Ontario Power Co.—This company was incorporated in New York in 1894 for the purpose of distributing electric power. Fifty-five per cent of its stock is owned or controlled by the Westinghouse Electric & Manufacturing Co., and 45 per cent is owned by the Ontario Power Co. of Niagara Falls. The Ontario company is a Canadian corporation with a development on the Canadian side of the Niagara River. The Niagara, Lockport & Ontario Power Co. owns no water power, but has a contract with the Ontario Power Co. of Niagara Falls for the purchase of 60,000 electrical h. p. This appears to be the only power produced by water that is practically controlled by strictly Westinghouse interests. In addition to the ownership of a majority of the stock of the Niagara, Lockport & Ontario Power Co. and a large amount of its bonds by Westinghouse corporations, George C. Smith is vice president and director of this company, and H. H. Westinghouse, C. A. Terry, and W. D. Updegraff are all directors. All of these individuals are officers or directors in one or more Westinghouse concerns. While the connection of the Westinghouse interests with the Ontario Power Co. of Niagara Falls is not direct it is of such a character as to indicate a very close relationship.

The Niagara, Lockport & Ontario Power Co. has transmission lines extending from Niagara Falls as far east as Syracuse, N. Y., and as far south as Lackawanna, N. Y.

Atlanta Water & Electric Power Co.—The details of this company have been discussed elsewhere (p. 125). George C. Smith, a prominent Westinghouse man, is a director of this company, and the Westinghouse Electric & Manufacturing Co. owns $400,000 of its $1,500,000 capital stock. This company is controlled by the S. Morgan Smith interests, and the presence of a Westinghouse director on its board is said to have no further significance than that he shall be in a position to take care of the Westinghouse interests.

Chattanooga & Tennessee River Power Co. and Utica Gas & Electric Co.—It is not probable that there is any considerable Westinghouse influence in these water-power concerns. Although A. N. Brady, a director in the Westinghouse Electric Manufacturing Co., is largely interested in these two companies, his connection appears to be of a personal nature. These companies are therefore classed under the Brady interests. (See p. 172.)

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It is seen from the foregoing that the Westinghouse control of water power is practically limited to the 60,000 h. p. purchased from the Ontario Power Co. of Niagara Falls, which is distributed in the western part of the State of New York.

WESTINGHOUSE INTERESTS IN PUBLIC-SERVICE CORPORATIONS.—The Westinghouse Electric & Manufacturing Co. owns a majority of the stock and a large proportion of the bonds of the Lackawanna & Wyoming Valley Rapid Transit Co. That company owns all the securities of five subsidiary companies, which own and operate a line of double-track electric railway from Wilkes-Barre to Scranton, Pa., a distance of 22 miles.

GOULD INTERESTS.—This group of water-power concerns is a part of the Virginia Railway & Power Co. The Virginia Railway & Power Co. was incorporated in Virginia in 1909 for the purpose of consolidating and purchasing the stock of the Richmond Passenger & Power Co., operating 57 miles of electric railways in Richmond and suburbs, and also an electric lighting and power plant; Richmond Traction Co., operating 21 miles of railway in the city of Richmond; the Richmond & Petersburg Electric Railway, operating an interurban railway of 23 miles, connecting Richmond, Manchester, and Petersburg; Southside Railway & Development Co., operating 14 miles of electric railway in Petersburg and suburbs, and supplying electric light and power in that city; Westhampton Park Railway, operating 5 miles of electric railway in Richmond and suburbs; Upper Appomattox Co., owning water rights for 30 miles on the Appomattox River above Petersburg; and the Virginia Electrical Railway & Development Co., owning water rights on the James River at Richmond and Manchester. The Fredericksburg Power Co., with its water power, was later acquired by the same interests. These railways embrace 120 miles of track.

In 1911, there was a further consolidation by the acquisition by the Virginia Co. of the Norfolk & Portsmouth Traction Co. The properties of this company consisted of the Port Norfolk Electric Railway Co.; the Portsmouth & Smithfield Railroad Co.; the Portsmouth, Pig's Point & Newport News Railway, Ferry & Hotel Co.; the Berkley Street Railway Co.; Old Dominion Railway Co.; Suffolk Light & Ice Co.; and, under a 99-year lease, the Norfolk Railway & Light Co. It also owns the entire capital stock of the Norfolk & Atlantic Terminal Co. and the Norfolk & Ocean View Railway. By the acquisition of the Norfolk & Portsmouth Traction Co. there came under the control of the Virginia Railway & Power Co. a system of electric railways with 140 miles of track; the ferries from Norfolk to Newport News and Old Point Comfort, and the City Gas Co., of Norfolk.

The Virginia Railway & Power Co. is controlled by F. J. Gould and Edwin Gould; both of them are members, and the former is chairman, of the executive committee.

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These interests own 21,600 h. p. of developed water power and 28,500 h. p. undeveloped. The water powers are shown in the following statement:

Company.	Developed.	Undeveloped.
	h. p.	h. p.
Old Dominion Iron & Nail Works, at Richmond	1,100	.....
Virginia Railway & Power Co., at Richmond	13,000	.....
Virginia Railway & Power Co., at Petersburg	3,000	3,000
Fredericksburg Power Co., at Fredericksburg	4,500	25,500
Total	21,600	28,500

The total water power, both developed and undeveloped, owned by these interests is 50,100 h. p. The developed power owned by these interests is more than 64 per cent of all the developed commercial water power in the State.

BRADY INTERESTS.—The companies classed under this head are those controlled by Anthony N. Brady. The corporations in this group that own water power are the Utica Gas & Electric Co. and the Chattanooga & Tennessee River Power Co. A. N. Brady owns a majority of the stock of the latter company, and he is president and director of the former. The water power owned by these companies is shown in the statement below:

Company.	Developed and under construction.	Undeveloped.
	h. p.	h. p.
Utica Gas & Electric Co., New York	11,800	16,200
Chattanooga & Tennessee River Power Co., Tennessee	58,800	.....
Total	70,600	16,200

These two companies own 86,800 h. p., developed and undeveloped. The Utica company also owns a steam plant in Utica with a capacity of 8,500 h. p. The Chattanooga & Tennessee River Power Co. is situated at Hales Bar on the Tennessee River about 18 miles from Chattanooga. The plant is nearly completed, and four turbines with a combined capacity of 16,800 h. p. have been installed. Six others with a total capacity of 25,200 h. p. will be installed as rapidly as possible, and provision is made for four others whenever the power demand shall warrant it, making a total of 14 wheels of 4,200 h. p. each. A transmission line is completed to Chattanooga, and a substation in that city is built. It is the purpose of the company to supply power to Chattanooga and South Pittsburg, Tenn., and Bridgeport, Ala.

The Utica Gas & Electric Co. was incorporated in New York in 1902 as a consolidation of the Equitable Gas & Electric Co. of Utica,

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and the Utica Electric Light & Power Co. In 1907 the Herkimer County Light & Power Co. was absorbed, thus giving the Utica Gas & Electric Co. control of the entire gas business and practically the entire electric-light and manufacturing-power business in Utica, Little Falls, Herkimer, Mohawk, Ilion, Frankfort, and other places in that vicinity. The company owns the entire capital stock of the Glens Falls Gas & Electric Light Co., and of the Consolidated Light & Power Co., of Whitehall. It also owns 51 per cent of the stock of the United Gas, Electric Light & Fuel Co. of Sandy Hill and Fort Edward, N. Y. The developed water powers of this company are Trenton Falls, 8,000 h. p.; Dolgeville, 3,400 h. p.; and Little Falls, 400 h. p., all in New York. It has undeveloped power at Trenton Falls estimated at 8,000 h. p.; at Little Falls, 1,700 h. p.; and at Prospect, 6,500 h. p.

Through the corporations controlled by stock ownership, the company supplies electric light and power to Whitehall, N. Y., and gas and electric light at Glens Falls, Sandy Hill, and Fort Edward, N. Y.

The control of these corporations by A. N. Brady brings them into relation with a number of other important public-service and industrial corporations. Mr. Brady is a director in the Westinghouse Electric & Manufacturing Co., the Kings County Electric Light & Power Co., and public-service corporations in Memphis, Albany, Chicago, Troy, and Utica. His son, Nicholas F. Brady, is a director in the Consolidated Gas, Electric Light & Power Co. of Baltimore. Representatives of the General Electric interests are likewise directors in the latter company, thus establishing to this extent a personal relation between Westinghouse and General Electric interests.

TELLURIDE POWER CO.—This company was incorporated in Colorado in 1900 as successor to the Telluride Power Transmission Co., which took over the electric-power business of the San Miguel Consolidated Gold Mining Co. In 1904 it absorbed the Logan Power, Lighting & Heating Co., of Logan and Provo, Utah, and subsequently purchased the Salt Lake City Water & Electric Co. L. L. Nunn is general manager. The company owns developed water power to the amount of 51,850 h. p.; 21,300 h. p. undeveloped. The details of the developed power are shown in the following statement:

Location.	Developed.	Location.	Developed.
Colorado:	*h. p.*	Utah:	*h. p.*
Old Ames	1,600	Provo	3,000
New Ames	5,000	Lower Provo	12,000
Illium	1,850	Battle Creek	4,800
Ouray	1,000	Jordan Narrows	1,000
Idaho:		Logan	2,900
Grace	18,700	Total	51,850

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The above statement of power owned by the Telluride Power Co. direct represents 51,850 developed horsepower. L. L. Nunn, general manager of the Telluride Power Co., is also president of the Beaver River Power Co., with a development of 4,500 h. p. at Beaver, Utah, making a total of 56,350 developed horsepower. It is estimated that 21,300 additional horsepower can be developed at the Grace, Idaho, site, thus giving the total volume of power, developed and undeveloped, under this control of 77,650 h. p.

The Telluride Power Co. has a transmission line from the Grace plant in Idaho to Salt Lake City, a distance of 135 miles. It furnishes power to many mining companies in southwestern Colorado, Utah, and parts of Idaho, and does the electric-lighting business of Ophir, Ames, Ouray, and Pandora, Colo. It also does the lighting business of Mercur, Eureka, Provo, Logan, and Brigham, Utah, and supplies a considerable part of the power used by the Utah Light & Railway Co., which controls the electric lighting of Salt Lake City and Ogden and operates the street railroads of Salt Lake City, with about 102 miles of track. The Beaver River Power Co. supplies light to Beaver and Milford, Utah, and power to mines at Newhouse, Utah, and vicinity.

HYDRAULIC POWER CO. OF NIAGARA FALLS.—This company is controlled by Arthur Schoellkopf and relatives and seems to have no personal or corporate connection with any other power-producing corporation. The water rights of this company at Niagara Falls are equivalent to approximately 164,000 h. p.

The company has two power houses. The installation of one amounts to 30,000 h. p. At the other power house there is installed 90,000 h. p., and construction work is now being done on an additional installation of 20,000 h. p., making the wheel installation installed and under construction at the two power houses 140,000 h. p. In addition to this the company sells 4,000 h. p. in the form of water, making 144,000 h. p. in all. Not all the wheels installed are in operation; two units of 10,000 h. p. each are held in reserve. The average daily load of both power houses is about 84,000 h. p., which, with the 4,000 h. p. sold as water, gives the daily output of power of this plant as 88,000 h. p.

Most of the current generated by this company is sold for manufacturing purposes; about 1,500 h. p. is taken for lighting and traction purposes.[1]

CLARK-FOOTE-HODENPYL-WALBRIDGE GROUP.—This group of interests consists of E. W. Clark & Co., interests composing the former firm of Hodenpyl, Walbridge & Co., and W. A. Foote. E. W. Clark & Co. are bankers and brokers in Philadelphia. Hodenpyl, Walbridge

[1] For details of conditions at Niagara Falls, see p. 133.

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& Co. were formerly bankers and brokers in New York City. W. A. Foote is the active head of a large group of water-power and other public-service corporations with which these banking firms are connected in the Southern Peninsula of Michigan (p. 129). In the early part of 1911 the firm of Hodenpyl, Walbridge & Co. was dissolved and two new firms known as H. D. Walbridge & Co., and Hodenpyl, Hardy & Co. were organized. Each new firm has some of the partners of the old with new members added. The dissolution of Hodenpyl, Walbridge & Co. apparently has no significance with respect to the relations of members of the old firm to public-service corporations.

It is probable that neither of the three brokerage concerns has any direct interest in either of the others, but their activities are so often manifest in the operation of the same corporations that they may properly be considered as allied interests.

The water-power and other public-service corporations involved in this influence are as follows: Commonwealth Power, Railway & Light Co. (Michigan); Union Railway, Gas & Electric Co. (Indiana and Illinois); Chattanooga Railway & Light Co. (Tennessee); Bangor Railway & Electric Co. (Maine); Lewiston, Augusta & Waterville Street Railway (Maine); Columbus Railway & Electric Co. (Ohio); St. Joseph Railway, Light, Heat & Power Co. (Missouri); East St. Louis & Suburban Co. (Illinois); Portland Railway, Light & Power Co. (Oregon); Denver & Northwestern Railway (Colorado).[1]

A number of subsidiary corporations are controlled by the companies named in the above list. This group of companies has water power developed and under construction to the amount of 104,300 h. p. and 158,000 h. p. undeveloped. Of the developed water power, 51,800 h. p. is in Michigan, 48,000 h. p. in Oregon, and 4,500 h. p. in Maine.

The activities of W. A. Foote appear to be confined to the Commonwealth Power, Railway & Light Co. and its subsidiaries, all operating in the Lower Peninsula of Michigan. The Clark-Hodenpyl-Walbridge interests are also connected with these Michigan companies; in fact, they were organized and financed by E. W. Clark & Co. and the old firm of Hodenpyl, Walbridge & Co., and some of the properties are operated and managed under their direction. All three of the brokerage firms have some interest in the Union Railway, Gas & Electric Co. and the Chattanooga Railway & Light Co. The remaining companies in the list appear to be distinctively Clark concerns. There is, however, a strong General Electric influence in the Portland Railway, Light & Power Co., and its water power has been included in the General Electric group.

[1] For details of the operations of the Commonwealth Power, Railway & Light Co. and the Portland Railway, Light & Power Co., see pp. 129 and 155, respectively.

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The Bangor Railway & Electric Co. is a consolidation of a number of street railway and electric lighting corporations in Bangor, Me., and vicinity with the Brewer Water Co. and the Penobscot Water & Power Co. It controls the Bar Harbor & Union River Power Co. It or its subsidiaries control developed water power to the amount of 4,500 h. p. and 12,000 h. p. undeveloped. It operates street and interurban railways with a total trackage of 63 miles, and supplies light and power in Bangor and vicinity.

The Lewiston, Augusta & Waterville Street Railway owns the electric railway running through the central part of Maine, touching the coast at Bath, and running thence northwesterly through Brunswick, Lisbon, Lewiston, Auburn, and Turner, and northeasterly through Sabattus, Gardiner, Hallowell, Augusta, East Vassalboro, Winslow, and Waterville, with additional lines radiating from Auburn and Augusta. It operates a total of 145 miles. It has a small hydroelectric power plant in Brunswick.

INTERESTS OF H. M. BYLLESBY & CO.—This is an engineering and managing company, similar in character to Stone & Webster. (See p. 163.) Its headquarters are at Chicago, Ill. H. M. Byllesby & Co. control the Northern States Power Co., Northern Idaho & Montana Power Co., Western States Gas & Electric Co., and Standard Gas & Electric Co., each of which is a merger or consolidation of a number of other corporations. The Byllesby company also controls the Sioux Falls Light & Power Co. in South Dakota. The Standard Gas & Electric Co. is not an operating concern, but owns and deals in the securities of other corporations. It holds a majority of the stock of the Western States Gas & Electric Co., and some of the stock of the Northern Idaho & Montana Power Co.

The Byllesby activities are not by any means confined to water powers. They are likewise concerned in the operation of gas, electric light, and power plants in Arkansas, Oklahoma, and elsewhere. Their water-power interests are generally closely affiliated with light and power plants. These properties afford another striking instance of the natural affiliation of water powers and other public-service agencies and of the tendency toward their consolidation.

The water powers under the Byllesby management are mainly owned by the Northern States Power Co., the Northern Idaho & Montana Power Co., and the Western States Gas & Electric Co., or their subsidiaries. Table 19 below shows the water powers owned by these corporations.

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TABLE 19.—WATER POWER OWNED BY CORPORATIONS UNDER THE CONTROL OR MANAGEMENT OF H. M. BYLLESBY & CO.

Company and location of power.	Water power.	
	Developed.	Undeveloped.
	h. p.	h. p.
Total	19,965	22,100
Northern States Power Co.:		
Apple River, Wis	1,600	1,000
Mankato, Minn	2,000	.....
Cannon Falls, Minn	1,500	1,500
Red Lake Falls, Minn	540	.....
Faribault, Minn	75	.....
Northern Idaho & Montana Power Co.:		
Big Fork, Mont	2,500	8,100
Albany, Oreg	750	.....
Mackenzie River, Oreg	.....	10,000
Western States Gas & Electric Co.:		
American River, Cal	5,000	1,500
Junction City, Cal	3,000	.....
Sioux Falls Light & Power Co., S. Dak	3,000	.....

From the above table it is seen that these companies own developed water power to the amount of 19,965 h. p., and 22,100 h. p. undeveloped. In addition to the power shown here the Northern Idaho & Montana Power Co. purchases 8,000 h. p. from the Washington Water Power Co., which is distributed at Sandpoint, Idaho, and vicinity. The Western States Gas & Electric Co. purchases 1,000 h. p. from the Pacific Gas & Electric Co., which is distributed at Richmond, Cal. The Northern States Power Co. owns four undeveloped sites on Red Lake River in Minnesota. Their development depends upon securing storage from Red Lake. If this storage is secured it is estimated that they will produce 6,000 h. p. These companies, therefore, utilize water power to the amount of 28,965 h. p., including that purchased from other water-power concerns, and their undeveloped power, including the possible development of Red Lake River, amounts to 28,100 h. p.

The Northern States Power Co. operates in Wisconsin, Minnesota, North Dakota, and Illinois. Its total developed water power is 5,715 h. p. It serves 25 cities and towns in these States and also furnishes power to the lead and zinc mines in the southwestern Wisconsin district. In Minnesota it furnishes gas and electricity in East Grand Forks, Faribault, Mankato, and Stillwater; it does all the electric lighting in St. Paul and South St. Paul; it does an electrical business in Cannon Falls, Dundas, Northfield, Randolph, Rapidan, Red Lake Falls, Waterford, West St. Paul, and White Bear Lake, and it does a gas business in Moorhead. It does an electric-light, gas, and steam-

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heat business in Fargo and Grand Forks, N. Dak. In Wisconsin it does all the electric lighting in Benton, Cuba City, Hazel Green, Platteville, and Somerset, and the gas business in Hudson. It does an electric-lighting business in Galena, Ill.

The Northern Idaho & Montana Power Co. operates in Montana, Idaho, Washington, and Oregon. It has a water-power development at Big Fork, Mont., and one at Albany, Oreg., 3,250 h. p. in all. It also owns an undeveloped site on the Mackenzie River in Oregon, estimated to develop 10,000 h. p. In Montana it operates electric lights, waterworks, and telephone service at Big Fork, Kalispell, and Polson; electric lights and telephone service at Columbia Falls and Whitefish; and telephone service at Dayton, Rollins, and Somers. It does an electric light and power business at Kootenai and Sandpoint, Idaho. In Oregon it does an electric light and power business and operates the waterworks at Albany, Independence, and Springfield; electric and gas business at Empire, Eugene, Marshfield, and North Bend; electric light and power business at Corvallis, Dallas, Harrisburg, Junction City, and Monmouth.

The Western States Gas & Electric Co. was organized to consolidate the American River Electric Co., the Humboldt Gas & Electric Co., the Richmond Light & Power Co., and the Stockton Gas & Electric Corporation, all in the State of California. With the Humboldt Gas & Electric Co. were acquired a water-power development of 3,000 h. p. and a steam plant of 2,000 h. p. capacity. The water-power plant is on Cannon Creek, about 65 miles from Eureka. With the American River Electric Co. was acquired developed water power to the amount of 5,000 h. p. The Western States company therefore owns developed water power to the amount of 8,000 h. p. and 1,500 h. p. undeveloped. It has steam plants with a generating capacity of 5,500 h. p. The companies now under the control of the Western States Gas & Electric Co. supply power to Alton, Arcata, Eureka, Ferndale, Fields Landing, Fortuna, Junction City, Richmond, San Pablo, Stegge, Stockton, and other towns. They do the street lighting in Eureka and Stockton, and supply power to the Stockton Electric Railroad. The power used at Stockton is purchased from the Pacific Gas & Electric Co.

In addition to the public-service corporations operated as subsidiaries to the three corporations above discussed, H. M. Byllesby & Co. operate steam electric plants in El Reno, Enid, Fort Gibson, Muskogee, and Oklahoma City, Okla.; Fort Smith, Ark.; Mobile, Ala.; Ottumwa, Iowa; Minot, N. Dak.; and San Diego, Cal.; and gas plants in Olympia, Tacoma, and Everett, Wash.

H. M. Byllesby & Co. apparently have no personal or corporate connection with any other large water-power owner. The purchase of large volumes of power from the Washington Water Power Co., and from the Pacific Gas & Electric Co., which dominates the power

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situation in a large portion of California, may have no especial significance.

INTERNATIONAL PAPER CO.—This company is engaged in the manufacture and sale of pulp and paper. It is in every sense an industrial concern, not being at present engaged in the commercial development of water power. It is given consideration here, however, because of the exceedingly large volume of water power owned and of the fact that from the nature of its business there is a strong probability that it will gradually enter the commercial-power field. The life of a pulp business is determined by the supply of raw material economically available. When the material convenient to a mill is exhausted, it would be but natural that the water power, in the absence of demand for other purposes, should be diverted to commercial use. In this connection it is interesting to note that the International Paper Co. has contemplated converting 12,000 h. p. at Wilder, Vt., into a commercial project.

The International Paper Co. operates 25 plants by water power. These plants are in five States—10 in New York, 9 in Maine, 3 in Vermont, 2 in New Hampshire, and 1 in Massachusetts.

The water power owned and leased and the total power used by the International Paper Co. are shown in the following table:

TABLE 20.—WATER POWER OWNED AND LEASED BY THE INTERNATIONAL PAPER CO., BY STATES.

State.	Owned.	Leased.	Total.
	h. p.	h. p.	h. p.
Total	158,304	32,071	190,375
Massachusetts	.....	3,425	3,425
Maine	40,376	11,006	51,382
New Hampshire	25,845	.....	25,845
New York	72,333	7,800	80,133
Vermont	19,750	9,840	29,590

From the above table it is seen that the company owns developed water power to the amount of 158,304 h. p. and that its leased power amounts to 32,071 h. p., making a total of 190,375 h. p. used. The power used in Massachusetts is rented from the Turners Falls Co. The rented power in Maine is leased from the Rumford Falls Power Co.; that in New York from the Niagara Falls Power Co.; and that in Vermont from the Bellows Falls Canal Co. The terms upon which all this power is leased are not known to the Bureau. It is known, however, that a portion of it is leased for 999 years, and that another portion is leased in perpetuity. Some of the companies from which power is leased are closely related to the International Paper Co. This is particularly true of the Niagara Falls Power Co. D. O. Mills, deceased, was a prominent figure in the International Paper Co., and one of the largest stockholders in the Niagara Falls Power Co., from which 7,800 h. p. is leased.

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In addition to the developed power used by the International Paper Co. it owns undeveloped power sites estimated to be capable of producing 44,400 h. p. The largest development owned by the company is 22,450 h. p. on the Hudson River at Palmers Falls, N. Y. It also owns 6,958 h. p. at Fort Edward on the Hudson and 15,000 h. p. undeveloped on the Hudson in this vicinity. The table shows that the company uses 80,133 h. p. in the State of New York, of which 72,333 h. p. is owned outright.

Section 6. Summary of concentration of ownership and control.

The more important large water-power companies have been discussed in detail in the preceding pages. A brief summary of the power owned by the ten largest owners, or groups of owners, more or less subject, respectively, to single large interests, is presented in Table 21 below, which shows the water power, both developed and undeveloped, controlled by each company, or group of companies, or affiliated interests having 50,000 h. p. or more.

TABLE 21.—COMMERCIAL WATER POWER CONTROLLED BY OR UNDER THE INFLUENCE OF COMPANIES OR GROUPS OF INTERESTS EACH HAVING 50,000 H. P. OR MORE ACTUALLY DEVELOPED OR UNDER CONSTRUCTION.

[The degree of control varies greatly, as set forth in the text.]

Companies or groups of interests.	Developed and under construction.	Undeveloped.	Total.
General Electric interests:	*h. p.*	*h. p.*	*h. p.*
A. Power completely controlled	82,860	5,500	88,360
B. Power coming under General Electric influence where there occurs both minority ownership of securities and common directors	419,060	522,600	941,660
C. Power coming under the sphere of General Electric influence through common directorships only	437,195	113,500	550,695
Total, General Electric group	[1] 939,115	[2] 641,600	1,580,715
Stone & Webster interests	278,067	372,350	650,417
Hydraulic Power Co. of Niagara Falls	144,000	20,000	164,000
Pacific Gas & Electric Co.	118,343	100,000	218,343
Clark-Foote-Hodenpyl-Walbridge interests	104,300	158,000	262,300
Southern Power Co.	101,680	104,000	205,680
S. Morgan Smith interests	76,550	96,000	172,550
Brady interests	70,600	16,200	86,800
United Missouri River Power Co.	65,000	.....	65,000
Telluride Power Co.	[3] 56,350	21,300	[3] 77,650
Grand total	[4] 1,821,305	[4] 1,449,450	[4] 3,270,755

[1] Includes 84,700 h. p. also included with Stone & Webster interests and 48,000 h. p. included with Clark-Foote-Hodenpyl-Walbridge interests.

[2] Includes 5,000 h. p. also included with Stone & Webster interests and 75,000 h. p. included with Clark-Foote-Hodenpyl-Walbridge interests.

[3] Including 4,500 h. p. belonging to the Beaver River Power Co.

[4] Does not include power duplicated in General Electric, Stone & Webster, and Clark-Foote-Hodenpyl-Walbridge interests.

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From the foregoing table it is seen that the ten companies or groups of companies with 50,000 developed horsepower or more, control a total of 1,821,305 h. p., developed and under construction, and that the same companies own 1,449,450 h. p., undeveloped, making a total of 3,270,755 h. p., developed and undeveloped, that is controlled or influenced by these ten companies and groups.

These companies control or have under their influence more than 60 per cent of all the commercial power developed and under construction in the United States. The companies controlled by or affiliated with the General Electric companies control 939,115 h. p., developed and under construction, or more than half of all the power, developed and under construction, involved in the table. The companies controlled by or affiliated with the General Electric companies and Stone & Webster interests together control a total of 1,132,482 h. p., developed and under construction, which is more than 62 per cent of all the power, developed and under construction, shown in the table. As shown later there is apparently some relationship between the General Electric and Stone & Webster interests. (See p. 183.)

The five largest groups of holders of developed water power in the United States control more than 50 per cent of all the commercial power developed and under construction in the country, besides having more than 1,200,000 h. p., undeveloped.

In addition to the large holders of power shown in the table there are four companies having each more than 40,000 h. p., developed and under construction, and three others having each 25,000 h. p. and less than 40,000 h. p. These seven companies together have 272,862 h. p. The 17 corporations and groups of corporations having 25,000 h. p. or more therefore control 2,094,167 h. p., developed and under construction, or about 70 per cent of all such commercial power in the United Sates.

Special large interests not included in the above discussion are the International Paper Co. and the Aluminum Co. of America. These two concerns have not been included because they are engaged almost entirely in the manufacturing business. As already stated (see p. 179) the business of the International Paper Co. is such that a portion of their water power will probably be turned to commercial use as the supply of pulp material is exhausted. This company owns more than 158,000 developed horsepower; the Aluminum Co. of America has 48,000 h. p. developed and 48,000 h. p. undeveloped.

In connection with the concentration of ownership and control of commercial water power it is very significant that in many localities all the power now developed, and in some localities nearly all that is available for future development, is in the hands of a single interest.

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The General Electric interests control almost completely the water-power situation in portions of Washington, Oregon, Colorado, Montana, and elsewhere; the Stone & Webster interests exercise similar control in localities in Washington, Iowa, and Georgia. The Pacific Gas & Electric Co. absolutely dominates the power situation in a large number of localities in California; the Southern Power Co. has practical control of the water-power situation in South Carolina and a strong foothold in North Carolina. The S. Morgan Smith interests dominate the water-power situation in the vicinity of Atlanta, Ga. The Telluride Power Co. controls a large territory in Utah and Idaho; and the Commonwealth Power, Railway & Light Co. completely dominates the water-power situation in the Lower Peninsula of Michigan. The Gould interests appear to control the best of the available water power in the vicinity of Richmond, Va.

Section 7. Interrelationship of large water-power interests.

Neither the extent nor the degree of concentration in the control of water power is fully revealed by the consideration of single groups of companies. They can be understood only by studying the relationship of such interests as the General Electric Co., Stone & Webster, S. Morgan Smith, Brady, and others, to water-power companies and to public-utility corporations. There is an interrelationship of these groups, or interests, themselves, that suggests the possibility, if not the probability, of still greater concentration in the ownership of water powers and public-utility corporations naturally allied with water powers, than appears in the discussion of any one group. This relationship is established in various ways. In some cases one interest owns stock and has directors in a water-power company that is managed or controlled by another interest. In other cases men identified as directors with two or more interests are also directors in a third company, either water-power or public-service. Again, a relationship is sometimes established through the influence of banks interested in the underwriting of the securities of water-power companies, and otherwise aiding their credit. This relationship is often not corporate, but purely personal. The fact that an individual is a director in two companies does not necessarily point to a close relationship. It must be admitted, however, that while such a relationship may not apparently be close, it tends to establish a bond of common interest that might at any time lead to a close connection or an actual consolidation.

The interrelationship of some large interests and the significance of the connection between them are pointed out in this section. It will be seen that certain water-power companies and other public-utility corporations controlled by or affiliated with one group of interests are closely related to those of another group, and this second

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group is in turn related to still another. The degree of relationship ranges from practically joint control down to simple personal association through a common director. As already intimated, there is seen here, as elsewhere in all large business, a tendency toward control by powerful financial interests. The banks supply the money for these enterprises and enter their directorates. These connections, some stronger and some weaker, but all friendly, suggest a favorable condition for a very small number of men to consolidate very large interests whenever they may think it advantageous to do so. This interlocking of interests through directorates, while not necessarily indicating a purpose of monopoly, certainly affords facilities for combination.

The relationship of certain large interests to water-power, street-railway, and lighting companies and the interrelationship of these interests are shown graphically in Chart 5 (opposite p. 184). The ramifications of the General Electric influence, as indicated by this chart, are particularly significant.

RELATION OF THE GENERAL ELECTRIC COMPANIES AND STONE & WEBSTER.—Two of the largest and strongest groups of interests in the water-power field are the General Electric companies and the Stone & Webster interests. The water-power companies and other public-service corporations under the control or influence of these two groups are found in every section of the United States. There are several water-power and other public-service corporations under the management of the Stone & Webster Management Association that have upon their boards of directors, or upon the boards of directors of the companies controlling them, men who are also found among the directors of the "General Electric companies." The water-power companies involved in this direct connection have a total development of 84,700 h. p. Chart 5 (opposite p. 184) shows the connection between the Stone & Webster and the General Electric interests. It will be seen from this chart that the large group of water-power interests in the Puget Sound region, in the State of Washington, and a number of street railway and lighting companies in the same region, are under the Stone & Webster management, and have connection through directors with the "General Electric companies." Furthermore, the General Electric companies own securities of several of these Stone & Webster concerns. Public-service corporations in such important centers as Dallas, Tex., and St. Louis, Mo., are also more or less connected with both these large interests.

S. MORGAN SMITH, WESTINGHOUSE, AND BRADY INTERESTS.—The details of these several interests have been discussed elsewhere. The connection between S. Morgan Smith and Westinghouse interests is through the Atlanta Water & Electric Power Co. This company is controlled by S. Morgan Smith interests, but the Westinghouse Electric

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& Manufacturing Co. owns a considerable portion (nearly 27 per cent) of its stock, and has representation on its board of directors. The connection between the Westinghouse and the Brady interests is through Anthony N. Brady, who is a director in the Westinghouse Electric & Manufacturing Co. The Westinghouse companies appear to have no direct control of any water-power development. Their interest in water power lies mainly in the fact that the Niagara, Lockport & Ontario Power Co., which they control, has a long-term contract with the Ontario Power Co. for the purchase of 60,000 h. p., which gives it virtual control over that amount of power generated at Niagara Falls. Anthony N. Brady personally controls the Chattanooga & Tennessee River Power Co. and is interested in the Utica Gas & Electric Co., thus indicating at least a sort of relationship between the group of water powers controlled by S. Morgan Smith interests and the Brady-Westinghouse interests. Brady and Westinghouse also have some connection, quite indirect, with the General Electric Co. Nicholas F. Brady, son of Anthony N. Brady, is a director in the Consolidated Gas, Electric Light & Power Co. of Baltimore, as is also S. R. Bertron, a director in the Electric Bond & Share Co. This company is one of the principal customers of the Pennsylvania Water & Power Co., in Pennsylvania, which likewise has a General Electric director. These relationships are all shown graphically on Chart 5. The Westinghouse Electric & Manufacturing Co. owns a majority of the stock of the Lackawanna & Wyoming Valley Rapid Transit Co.

OTHER INTERRELATIONSHIPS.—The large group of water powers in the Lower Peninsula of Michigan, already discussed under "Concentration in the Lower Peninsula of Michigan" (see p. 128), are closely connected with E. W. Clark & Co. and Hodenpyl, Walbridge & Co. interests. The dominant spirit in the practical management of the Michigan companies is W. A. Foote, and these companies have been largely financed by E. W. Clark & Co. Clark & Co. are connected through directorates with the Bangor Railway & Electric Co., which owns water power in Maine, and a number of street railway and lighting companies in various sections of the country, as will appear from an inspection of Chart 5. The Clark concern is also represented on the directorate of the Portland Railway, Light & Power Co. (General Electric), thus connecting these interests with the General Electric interests.

Another group of vast proportions centers in the United Railways Investment Co. This company controls the United Railroads and other properties in San Francisco. They also control the Philadelphia Company, which in turn controls 14 street railways, 8 electric-light and gas companies, and 6 fuel-gas companies in Pittsburg, Pa., and vicinity. The Railroads & Power Development Co., of San

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isco, which is controlled by the United Railways Investment
tself controls the Sierra & San Francisco Power Co., a large
-power concern in California which supplies power to the
d Railroads of San Francisco. The Sierra & San Francisco
r Co. has upon its board of directors a prominent General
ric representative.

MMARY.—Summarizing these interrelationships it is seen that
eneral Electric Co. and its three wholly controlled subsidiaries
some sort of connection or relation with at least six other large
ests. An examination of Chart 5 will show the character of
interrelationships. There is also shown on the chart the rela-
of the General Electric companies to banks and financial houses.
eferring to the list of banks (p. 162) the General Electric finan-
connections can be seen. There is thus brought into more
ss close relationship a vast volume of water power and a great
ber of street railway and lighting companies, besides steam
oads and a number of the largest banking interests in this country.
ere is here presented such a situation in water powers and other
ic utilities as might bring about at any time under a single man-
nent the control of a majority of the developed water power in the
ed States and similar control over the public utilities in a vast
ber of cities and towns, including some of the most important
e country.

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CHAPTER IV.

RELATION OF WATER-POWER COMPANIES TO MUNICIPAL PUBLIC-SERVICE CORPORATIONS.

Section 1. Nature and extent of such relationships.

The preceding discussion has clearly developed the existence of exceedingly important interrelationships between water-power concerns and various public-service corporations. In the case of the General Electric companies, in particular, it was shown that aside from the control of water-power properties there was a very extensive General Electric domination of public utilities. Such interests of Stone & Webster, and various other water-power concerns, were also shown to be exceedingly important.

In most cases the relation between water-power companies and street railways and lighting corporations is that of ownership; but in some cases there is only affiliation, indicated by common officers or directors, or by sale of power, or both. Sometimes power companies have contracts with railway and lighting companies with which they have no corporate or personal relation. The sale of power may not in itself constitute an affiliation, but be no more than the relationship that arises out of a contract between buyer and seller.

In many towns the same company controls both gas and electric lighting, and so holds a complete lighting monopoly.

A brief summary of the most important instances of such interrelationship already discussed is presented in Table 22 below:

TABLE 22.—NUMBER OF TOWNS IN WHICH GIVEN WATER-POWER COMPANIES AND GROUPS OF COMPANIES OR AFFILIATED COMPANIES OWN AND OPERATE PUBLIC UTILITIES.

Company or group.	Street railways.	Electric-lighting plants.	Gas plants.
Pacific Gas & Electric Co.	1	40	18
Pacific Light & Power Corporation	2	29	2
Commonwealth Power, Railway & Light Co.	3	18	6
Southern Power Co.	2	14	2
General Electric companies.	16	78	19
Stone & Webster companies.	5	25	8
Total.	29	204	55

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From the above table it is seen that the six water-power companies or groups included therein control the street railways in 29 towns, electric lighting in 204, and gas plants in 55. The General Electric companies and the Stone & Webster companies control public utilities in a considerable number of towns that have been excluded from the above table because they have no direct connection with water-power developments.

In many cities the water-power companies control two and in some they control all of the three classes of public utilities shown in the table. Some instances conspicuous for the completeness with which water-power interests control the street-railway and lighting business of cities are the Portland Railway, Light & Power Co., at Portland, Oreg.; Manchester Traction, Light & Power Co., of Manchester, N. H.; and the Utah Light & Railway Co., at Salt Lake City, Utah.

The approximate number of cities and towns in the United States including those in Table 22, in which public utilities are owned or operated by water-power concerns, or in which the street-railway and lighting corporations own water power as of about January 1, 1911, is shown in Table 23, below. The table also shows the number of municipal lighting plants that are supplied with current by water-power companies:

TABLE 23.—NUMBER OF TOWNS IN THE UNITED STATES IN WHICH PUBLIC UTILITIES ARE OWNED OR OPERATED BY WATER-POWER COMPANIES OR COMPANIES AFFILIATED THEREWITH, AND MUNICIPAL LIGHTING PLANTS SUPPLIED WITH CURRENT, BY CLASSES AND BY STATES, ABOUT JANUARY 1, 1911.

State.	Street railways (towns).	Electric-light plants (towns).	Gas plants (towns).	Municipal lighting plants supplied with current.
Total	111	669	113	19
Alabama	2	3	3	.....
California	8	151	37	4
Colorado	1	22	.....	.....
Connecticut	16	32	4	1
Florida	1	1	.....	.....
Georgia	4	5	1	2
Idaho	.....	19	1	1
Illinois	.....	7	.....	.....
Indiana	.....	6	.....	1
Iowa	.....	2	.....	.....
Kansas	.....	5	2	.....
Maine	16	36	3	.....
Maryland	.....	14	1	.....
Massachusetts	.....	15	.....	1
Michigan	5	50	6	2
Minnesota	3	13	5	2
Missouri	.....	3	.....	.....
Montana	3	14	2	.....
Nevada	.....	19	2	.....

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TABLE 28.—NUMBER OF TOWNS IN THE UNITED STATES IN WHICH PUBLIC UTILITIES ARE OWNED OR OPERATED BY WATER-POWER COMPANIES OR COMPANIES AFFILIATED THEREWITH, AND MUNICIPAL LIGHTING PLANTS SUPPLIED WITH CURRENT, BY CLASSES AND BY STATES, ABOUT JANUARY 1, 1911—Continued.

State.	Street railways (towns).	Electric-light plants (towns).	Gas plants (towns).	Municipal lighting plants supplied with current.
New Hampshire	4	18	.....	.....
New Jersey	.....	1	.....	.....
New York	6	71	20	.....
North Carolina	4	16	4	1
North Dakota	.....	1	.....	.....
Ohio	6	2	.....	.....
Oregon	3	29	5	.....
Pennsylvania	.....	7	5	.....
Rhode Island	3	6	1	.....
South Carolina	2	9	1	2
South Dakota	.....	5	.....	.....
Tennessee	.....	1	.....	.....
Utah	1	14	.....	.....
Vermont	5	25	3	.....
Virginia	5	9	2	1
Washington	5	24	3	.....
West Virginia	.....	1	.....	.....
Wisconsin	8	13	2	1

It is probable that this table understates the number of towns in which public utilities are owned and operated by water-power companies or by companies affiliated with them. Whenever there appeared any doubt of the ownership or control of a street railway or lighting plant by a water-power company the city or town was excluded. A considerable number of interurban electric railways controlled by water-power companies have also been omitted.

The table shows that water-power companies or companies affiliated with them own or control, and operate the street railways in 111 cities and towns in the United States, the electric lighting plants in 669 cities and towns, the gas plants in 113 cities and towns, and that these companies supply current to municipal lighting plants in 19 cities and towns. Many of the municipalities thus supplied with street railway and light service by water-power companies are small. A considerable number, however, are among the most important municipalities in the respective States. The important fact is that an entire community of people is dependent upon a private monopoly for the means of transit and lights and the character of service that shall be given.

It should be noted that to add together the number of cities and towns shown in connection with the three classes of public-service companies would involve considerable duplication. For instance many of the communities in which the electric-lighting plants are ow-

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water-power companies are also included in the communities in which street railways are so owned.

Section 2. Consolidations of public-service corporations themselves.

The importance of this relationship between water-power concerns and public-service corporations is greatly enhanced because of the fact that during recent years there has been a rapid consolidation of gas and electric lighting companies and, to a somewhat less extent, a consolidation of lighting and street-railway companies. These consolidations are not confined to single cities; but in several instances all the local transit and lighting facilities in several towns have been gathered under a single control.

The properties of these consolidations are often in widely separated communities. Notable instances are the American Cities Railway & Light Co., operating in four States; the American Gas & Electric Co., operating in seven States; Stone & Webster, in eleven States; the United Railways Investment Co., controlling the street railways of San Francisco and vicinity, 263 miles of track; and street and interurban railways in Pittsburg, Pa., and vicinity, more than 640 miles of track, and supplying fuel and lighting gas and electric power in Pittsburg and vicinity. There are other similar combinations, but these are sufficient to indicate the tendency toward concentration of ownership of public utilities in our cities. These utilities naturally sustain a close economic relation to water powers.

The far-reaching importance of these conditions is greatly emphasized by the fact, already brought out, that consolidations of water-power companies and street railway and lighting corporations are seen on every hand. A common control of the agencies of passenger traffic and of distributing light in our cities, on the one hand, and of the sources of energy for operating these utilities, on the other, is a fact of great public importance.

Concentration along this line is constantly increasing in scope and strength. There are steady additions to the list of public-service agencies controlled by or affiliated with water-power concerns. Combinations heretofore formed are being merged into larger and stronger ones, and these larger units of management show a close relationship one to another.

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PART III

WATER POWER AND THE PUBLIC

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Part III. WATER POWER AND THE PUBLIC.

CHAPTER I.

PUBLIC OWNERSHIP OR CONTROL.

Section 1. Introductory.

The most desirable water powers in the older sections of the United States are now owned by private corporations. This is true of much of the power in all sections of the country. The amount of developed power privately owned has already been discussed. The extent to which the public still owns power and the degree of governmental control at present exercised over power sites and the character and scope of regulative authority applied to developed power are considered here.

Section 2. Water power owned or whose development is controlled by the United States.

The Federal Government actually owns comparatively little developed water power. All the power so owned is that developed at dams constructed for the improvement of navigation and in the prosecution of irrigation projects. Rights to develop water power in national forests, on military reservations, and on the public domain not withdrawn from entry are, under existing practice, acquired from the States in which the power sites are situated. Even as at present administered, however, the Federal Government is a necessary factor in the development of power on the public lands or within the reserves, whether on navigable or nonnavigable streams, by reason of the fact that a water power can not be developed without the occupancy and use of the lands for dams and transmission lines.

Thus, while the Forest Service does not exercise direct control over the water power in the forest reserves, it does control it in an indirect way. The Federal Government owns the land the use of which must be had for the erection of dams and construction of transmission lines. The Secretary of Agriculture is authorized by Congress to issue permits for the use of land within the reserves for these purposes upon a finding by the Forester that it is not incompatible with the public interest and to make a charge for such use. The Forest Service, therefore, can determine whether a development shall be

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made or not. In the issuance of such permits, however, no attempt is made to adjudicate water rights as such.

A dam can not be erected in a navigable stream, however, whether on the public domain or not, for the development of power without the consent of Congress, which is given by special act. Having the right to grant permission to dam the stream or to withhold the same, Congress may impose conditions on the grant. The exact extent and nature of the conditions which may be so imposed are matters upon which opinions now differ. The general dam act of 1906 as amended by the act of 1910 provides that the Secretary of War may require, among other things, from anyone so damming a navigable stream compensation for any direct benefit derived from any storage reservoirs maintained by the Government at the headwaters of the stream, or from the acquisition and maintenance of any forested watershed, or lands at the headwaters of such stream, wherever such shall be for the benefit of the navigation of the stream. Whether or not Congress may impose conditions on such a grant which do not pertain to such direct operation of the Government, or to navigation or to any power expressly delegated to the Federal Government by the Constitution, is the special point upon which some take a negative position, as, for example, whether a rental charge may be imposed on such grants.

The control of the Federal Government over the development of power on the public domain, in the various Federal reservations, and on navigable streams not on the public domain, as at present exercised, is therefore very great, with the right in the Government still further to extend control.

WATER POWER IN NATIONAL FORESTS.—The amount of water power capable of development in the national forests or dependent for development upon the use of land included in the national forests has never been determined with exactness. The Forest Service has roughly estimated the amount of power in the national forests now undeveloped but capable of development at 13,624,000 h. p. This estimate is intended to represent the practical maximum power; that is to say, the wheel installation that is practicable from an engineering standpoint. The estimate, therefore, is greater than the minimum potential power and less than the theoretical maximum potential. These figures are in many instances based upon imperfect data, and it is probable that the actual amount of power that can be developed is less than this estimate. Furthermore, much of the power in the forest reserves is far from centers of activity, and while its development is practicable from an engineering point of view, for economic reasons it will be many years before it can be an important factor in the power situation. There is now developed in the national

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forests and operated under permits from the Forest Service a total of 294,575 h. p.

The important relation that water power bears to the public makes it desirable that the approximate amount of potential water power commercially available in the national forests and upon other portions of the public domain should be determined without any undue delay.

OTHER SECTIONS OF THE PUBLIC DOMAIN.—The amount of water power on other parts of the public domain is more uncertain even than that in the national forests. It is certain that the amount of this power is far less than that in the forest reserves.

POWER ON INDIAN RESERVATIONS.—Nothing definite is known as to the water power on Indian reservations. It is safe to say, however, that it is comparatively small in amount and that it is not a very important factor in the general water-power situation.

IRRIGATION PROJECTS.—The power developed in connection with United States irrigation projects so far as at present determined is 16,300 h. p. In addition to this, it is estimated that 56,690 additional horsepower can be developed at those projects. Irrigation dams are constructed primarily to utilize water for agricultural purposes, and power developed thereby is only an incident. Moreover, a considerable portion of the power so developed is utilized by the Government for the operation of pumps, and power for commercial use developed at irrigation dams is of comparatively little importance.

POWER AT DAMS CONSTRUCTED FOR THE IMPROVEMENT OF NAVIGATION.—The amount of power available from Government dams constructed for navigation improvement is small. The total 12-months power thus developed in the United States is 23,800 h. p., and there are 50,734 h. p. additional that is available for eight months in the year. More than half of this power is at Hales Bar on the Tennessee River and is being produced by private capital under a 99-year lease. It should not be considered in this discussion. The Federal Government will have no control over the disposition of the power at the Hales Bar development until the expiration of the lease. Omitting the Hales Bar development there remain but 7,870 twelve-months horsepower and 22,984 eight-months power available at all Government dams. All of the 12-months power except about 1,000 h. p. and all of the 8-months power except 127 h. p. thus available are on the Muskingum River in Ohio. The remainder is on the Kentucky and Green Rivers, in Kentucky.

The power at present available from navigation improvement is of little practical importance. The amount available at any one dam is usually too small to warrant the installation of electrical machinery and transmission lines, and there is usually no great demand for power immediately at the dam. In consequence of this situation,

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out of a total available power, including the 8-months and the 12-months, of approximately 30,800 h. p. only 1,566 h. p. is used. The power used at these dams is sold in the form of water, and the amount received in rentals by the Government amounts to about $6,000 per year.

Section 3. Water power owned or controlled by the States.

The extent to which the title to water power is in the States is not entirely clear, apparently differing in different sections. In general, in the older States, a fair statement of the situation seems to be that water power is a riparian right. In other words, the owner of land through which a stream flows, be it navigable or nonnavigable, has a right to the usufruct of the water, whether for power or other purposes. In the arid States of the West, State statutes or constitutional provisions usually declare that the water in *all* natural streams within the State is the "property of the public," or "belongs to the public," or is "the property of the State." Apparently the object of these declarations is to abolish the common law of riparian rights, not only on navigable but also on nonnavigable streams, and to permit appropriation for beneficial uses in contravention of the common law. Constructions by different State courts of these provisions, however, differ widely, and in some cases it is held that the riparian proprietor may not, under such statutes, be deprived of all benefits of the stream. It is desirable to note that such statutes may in some cases be open to question as being in conflict with the Federal Constitution; first, with that clause providing that Congress shall have power to dispose of and make all necessary rules and regulations respecting the territory or other property of the United States; second, with that which declares that no State shall deprive any person of property without due process of law.

The amount of power absolutely owned by States and not subject to private appropriation, is comparatively small.

The State of Illinois owns approximately 100,000 h. p. undeveloped on the Illinois River, and has voted $20,000,000 in bonds for its improvement. The State of New York owns large tracts of land in the Adirondack Mountains, upon which there is quite a large volume of power.

Section 4. Water power owned by cities and towns.

MUNICIPALITIES OWNING 1,000 H. P. OR MORE.—There are 105 cities and towns in the United States that own water-power plants. About 80 per cent of these municipalities have developments of less than 1,000 h. p. Those that own water power to the extent of 1,000 h. p. or more (developed and undeveloped) are shown in Table 24.

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14.—CITIES IN THE UNITED STATES OWNING 1,000 H. P. OR MORE, DISTINGUISHING BETWEEN DEVELOPED AND UNDEVELOPED POWER.

State.	City.	Developed.	Undeveloped.	Total.
stal		h. p. 116,867	h. p. 183,665	h. p. 300,532
ia	Los Angeles	2,585	117,415	120,000
	Augusta	12,027		12,027
	Sanitary District of Chicago	28,000	48,000	76,000
	Logansport	1,125		1,125
	Enterprise	1,000		1,000
	Bangor	1,350		1,350
[illegible]usetts	Holyoke	1,040		1,040
Michigan	Crystal Falls	1,200		1,200
Do	Marquette	1,200	600	1,800
Do	Sturgis	1,280		1,280
Utah	Logan	3,600		3,600
Vermont	Lyndonville	900	100	1,000
Do	Morrisville	1,000		1,000
Virginia	Harrisonburg	1,350		1,350
Do	Martinsville	1,000		1,000
Do	Richmond	3,050	1,650	4,700
Washington	Ellensburg	1,660		1,660
Do	Seattle	20,800	14,200	35,000
Do	Tacoma	32,000		32,000
Wisconsin	Black River Falls	500	700	1,200
Do	Greenwood	200	1,000	1,200

From the above table it is seen that the most important municipal plants in the United States are those at Los Angeles, Cal.; Seattle and Tacoma, Wash.; Chicago, Ill.;[1] and Augusta, Ga.

The largest owner of power among the cities of the United States is Los Angeles. That city is building a water-supply aqueduct about 225 miles long, and in conjunction therewith it is estimated that 120,000 h. p. will be developed. It is the purpose of the city to supply itself with current for municipal use and to sell the remainder of the power. At present only 2,585 h. p. has been developed. This small development has been made to supply power for construction work. The city, in April, 1910, voted to issue bonds to the amount of $3,500,000 to cover the cost of the plant.

The city of Augusta, Ga., owns no installation but sells its power in the form of water to the local street railway and lighting plants and to a number of local manufacturers.

The large municipal plant at Tacoma, Wash., is now under construction. More than one-third of the work is completed and it is expected to have the plant in operation before the middle of 1912. The Seattle plant is partially completed and is delivering current

[1] The water-power plant of the Sanitary District of Chicago has been included in this table for the reason that the greater portion of the power generated is used for lighting the city of Chicago and is furnished to the municipality at cost.

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over its transmission line, a distance of 40 miles. The street-lighting system formerly owned and operated by the Seattle Electric Co. was purchased, and is now operated, by the city.[1]

The Sanitary District of Chicago has a completed water-power plant on the Drainage Canal with an installation of 28,000 h. p., and it is estimated that there is 48,000 h. p. undeveloped. The plant is now supplying a large portion of the current necessary to light the city of Chicago. A recent report of the executive committee of the Citizens Association of Chicago shows that for the six months ended June 30, 1910, the power plant made a net profit of approximately $62,000, after deducting operating expenses, depreciation and interest on the cost of the plant. This profit was derived entirely from commercial business, since the municipality was supplied with power at cost.

MUNICIPALITIES OWNING LESS THAN 1,000 H. P. EACH.—Of the 105 cities and towns owning water power in the United States, 84, or about 80 per cent, have less than 1,000 h. p. Only 8 of these have 500 h. p. or over. The number of towns in each State that own water power amounting to less than 1,000 h. p. each, and the total water power and steam power owned by these towns, are shown in Table 25.

TABLE 25.—NUMBER OF CITIES AND TOWNS IN THE UNITED STATES OWNING DEVELOPED WATER POWERS OF LESS THAN 1,000 H. P. EACH, AND THE WATER POWER AND STEAM POWER OWNED, BY STATES.

[Compiled from McGraw Electrical Directory for October, 1910.]

State.	Cities.	Water power.	Steam power.	State.	Cities.	Water power.	Steam power.
		h. p.	h. p.			h. p.	h. p.
Total	84	20,111	6,410	New Jersey	1	112	.....
				New York	6	1,873	250
Alabama	2	332	.....	North Carolina	2	550	.....
Connecticut	2	375	1,275	Ohio	1	175	412
Georgia	2	450	150	Oregon	3	680	300
Idaho	1	187	.....	Pennsylvania	3	538	375
Illinois	1	340	200	Tennessee	2	600	.....
Indiana	1	100	125	Utah	8	1,678	150
Iowa	2	380	397	Vermont	8	2,110	90
Maine	2	400	.....	Virginia	4	1,205	.....
Massachusetts	1	125	403	Washington	1	50	.....
Michigan	15	3,937	1,745	Wisconsin	9	2,197	260
Minnesota	4	912	82	Wyoming	1	40	36
New Hampshire	2	765	160				

None of the cities included in the above table, so far as is known to the Bureau, owns any undeveloped water power. In a few instances internal-combustion engines are owned, and they have been included

[1] The dam of the Seattle plant was recently broken by a flood.

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ıam power. In nearly all cases the power generated in these cipalities is used for lighting and pumping purposes only. There few instances in which the municipal plants supply power to facturers.

n 5. Existing public regulation or control.

DERAL REGULATION.—For the occupancy and use of forest lands nection with commercial water power the Department of Agri- e has fixed rates which it charges for such use. These rates are upon the net electrical horsepower developed. The depart- however, does not exercise any control over the rates that shall arged the public.

water powers on other portions of the public domain are under the jurisdiction of the Secretary of the Interior. He has power to grant permits for the occupancy and use of the public lands.

The power on military reservations can be developed only on a permit granted by the Secretary of War. The development of that on Indian reservations must have the approval of the Secretary of the Interior.

STATE REGULATION.—A number of the States have by statute placed commercial water-power developments in the class of public-service utilities and have made some provision for the control of hydroelectric developments and the regulation of rates that shall be charged the public. The statutes generally do not represent any effective, well-defined public policy.

New York.—In 1907 the State Water-Supply Commission was directed to devise a practical plan for the general development of the water powers of the State. This commission examined a number of streams and watersheds and made a comprehensive report upon the water resources of the State. The State, however, is confronted with a difficulty in the way of the development of its water-power resources in the shape of a constitutional provision that prohibits the lease, sale, or exchange of lands of the State constituting forest reserves, or the removal or sale of timber thereon. This prevents the flooding of sections of the State forest which might be made into reservoirs.

The New York Public Service Commission has authority to regulate water-power companies doing an electric-power business. The consent of the commission is necessary to the issue of stocks and bonds. A uniform system of accounts may be prescribed, and the commission has power to fix standards of service. It can either upon its own motion or upon complaint investigate rates and enforce just and reasonable charges.

Wisconsin.—Wisconsin has a comprehensive law controlling water powers and regulating rates charged the public for power. This law

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declares the use of navigable waters for power developed under a franchise to be a public use, and that all energy, developed and undeveloped, is subject to the control of the State for the public good. It is further declared that the beneficial use and natural energy of the waters of the State for all public uses are held by the State in trust for all the people.

All repealable licenses, permits, or franchises authorizing the erection and maintenance of a dam across any navigable stream were repealed. Provision was made for the granting of other franchises for a term of 20 years upon compliance with certain specified requirements. The appropriator of water under a new franchise is given the right to continue his franchise for two further successive terms of 10 years each upon filing the proper application with the railroad commission, subject, however, to the right of the State to readjust the value of the franchise. Each appropriator of water during the life of his appropriation is required to pay a State franchise fee equivalent to 5 per cent per annum of the franchise value of every horsepower produced and put to beneficial use; in no case, however, can this franchise fee be less than 10 cents nor more than $2 per horsepower. The franchise value is fixed as nearly as possible at the difference in the cost of producing a horsepower at the place of generation by water and the cost of producing at the same time, in like quantities, on an equivalent basis, a horsepower by the use of any kind of fuel. The State Railroad Commission is directed to fix the franchise value and is required to take into consideration all the elements of cost involved in the production of power by both methods. A further and important requirement of the law is that if the public convenience and necessity require it, any appropriator maintaining a dam under a franchise granted by the State shall develop all the power created by the dam and capable of development, and all such power not necessary for the purposes of the owner shall be sold to the public. The execution of the law and the determining of rates charged the public is vested in the State Railroad Commission.[1]

Vermont.—The Public Service Commission has power to regulate the quality of the product, fix rates and standards of service, hear complaints, and supervise the issue of stocks and bonds of gas and electric plants.

Georgia.—The State Railroad Commission of Georgia has authority over electric light and power companies. It has power to prescribe forms of accounts, compel reasonable service, fix rates, and to regulate the issue of stocks and bonds. The Georgia law gives the Railroad Commission jurisdiction over the power of the generating

[1] Since this report was put in type the supreme court of Wisconsin has declared the water-power law referred to here to be unconstitutional. The grounds for the decision appear to be that the effect of the act is to take private property (*a*) without compensation, (*b*) without due process of law, and (*c*) for private purposes.

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company only but not over the rates that shall be charged by a distributing company that purchases its power from another concern.

Massachusetts.—The Board of Gas and Electric Light Commissioners has power to regulate the issuing of stocks and bonds and to compel just and reasonable charges to the public.

Michigan.—The Railroad Commission of Michigan has authority over the transmission and supplying of electricity and has power to fix rates and control the issue of securities.

South Carolina.—The Public Service Commission of this State has jurisdiction over electric light and power companies and can regulate rates charged the public.

Other States.—Ohio, New Jersey, and Maryland have commissions with powers to regulate charges for gas and electricity to the public. These States, however, have very little water power except power transmitted from Pennsylvania into Maryland.

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CHAPTER II.

RELATION OF WATER POWER TO THE PUBLIC.

Section 1. Essential elements of the water-power problem.

The "commercial" use of water power has covered not more than 25 years, and its extensive use scarcely more than the last decade. Correct information as to the facts and tendencies of such use has not yet been widely disseminated, and the public has not yet had an opportunity to grasp the fundamental principles involved therein. It is of the highest consequence that a correct public opinion upon the problems thus involved in the use of water power be arrived at. As will be shown later, the water-power situation is such that it requires the prompt adoption of a positive governmental policy—either State or Federal, or both. The very fact that one, and indeed two, of the great natural resources of the country are involved, calls for such a policy. A special consideration is the fact that the public, through either the Federal Government or the States, still owns or absolutely controls a considerable portion of our undeveloped power resources. There is, however, going on a rapid acquisition of water powers by private interests, and vested rights are accruing therein. This process more and more limits the field of effective public control and demands the early adoption of some definite policy. The fundamental problems involved in any such policy are these:

1. The best development of the resource.
2. The protection of the consumer.
3. The reservation, for the benefit of the whole public, of its proper share in the advantages inherent in the natural resource itself.

Section 2. Desirability of early, complete, and efficient utilization of water power.

Water power is unlike most other natural resources in that it is not diminished by use, nor is it conserved by nonuse. Coal which is not used to-day remains to be used hereafter, but the energy of water which is allowed to flow by unused neither increases nor decreases the future supply, but is irretrievably lost. Our supply of coal—the principal source of energy—while vast, is not unlimited. The utilization of water power results in the saving of coal for future use. In other words, the real waste of water power is its nonuse, while its development effects a conservation, not only of water power, but of our fuel supply as well.

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The importance of effectively utilizing the water powers of the country is therefore obvious. The power now (February, 1912) required to operate the industrial enterprises and public-service utilities of the country (excluding steam railroads and vessels) can be safely estimated at not less than 30,000,000 h. p. Approximately 6,000,000 h. p. is now generated by water. The remainder is generated from fuel, mainly coal. The quantity of coal required to produce a "horsepower-hour" in steam varies according to the quality of the coal and the size and efficiency of engines. It is claimed that under the most favorable conditions a pound of coal can be made to produce one horsepower-hour. From this minimum the estimated quantity ranges as high as even 6 or 7 pounds. Assuming, however, that on the average a horsepower-hour in steam can be produced by 3 pounds of coal (and this quantity probably understates the average quantity of coal required, and the corresponding saving by the substitution of water power), the power now produced by water saves at least 33,000,000 tons of coal per year. This is based on a 12-hour day.

By reason of distance from markets, cost of development, and other causes, it will doubtless be many years before a quantity equal to even the "minimum potential" water power of the country (see p. 55) can be advantageously developed. It is certain, however, that under favorable conditions several additional millions of horsepower can now profitably be developed from water, thus effecting a still further conservation of our fuel. The millions of water power economically available, but undeveloped, represent absolute waste.

In brief, the real conservation of water power is its use. So much of this natural resource, therefore, as can advantageously be used should have prompt and complete development; but in doing this certain important economic forces are called into action, and the effect of these forces upon the public welfare must be fully recognized, and the public interests safeguarded.

Section 3. Protection of the consumer involves a broader problem than regulating prices.

The commercial power industry is one which, by its very character, involves highly monopolistic tendencies, so that competition can not be relied upon to protect a large portion of the consuming public against unreasonable or unfair charges for power. (See p. 207.) This is true of all power, whether generated from fuel or from water.

To deal intelligently with the power question, it is important to keep clearly in mind the elements composing a commercial power system. There are two coordinate elements in every such system, namely, the generating plant and the distributing equipment. In a water-power development, owing to the fact that the water-power

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site is usually at a considerable distance from the consuming market, there is also a third factor, namely, the "transmission" system; that is, main-line transmission, as distinguished from local distribution. In supplying power from fuel the generating plant can usually be located so as to permit distribution directly from the point of production. One of the chief points of physical difference, therefore, between a water-power system and a fuel-power system is in the "transmission" equipment of the former. In very few instances are transmission lines (as distinct from distributing lines) found in connection with fuel-power plants. The reason for this undoubtedly is that it is usually more economical to transport the fuel to the generating plant than to transmit the power to the consuming market.

THE MONOPOLY ELEMENTS OF A POWER SYSTEM.—The prime element of monopoly in a commercial power system lies in the distributing lines. Before a commercial power concern, whether using water or fuel, can operate on any extensive scale it must have access to the great body of power users. Such access can be had only through a distributing system requiring a large investment and involving the use of streets in cities and towns (and, in the case of a water-power concern, a right of way and additional investment for its transmission lines). The conditions under which the local distribution of power is effected are such that, as a matter of practical experience, effective competition is seldom encountered. It does not matter so much whether a franchise to construct a power-distributing system legally excludes competition or not. Experience has shown that in analogous cases, such as the duplicating of gas plants, etc., competition ordinarily is short lived, regardless of legal conditions. The maintenance of two or more power-distributing systems in the same community generally involves a waste of capital, commonly results in the absorption of the weaker concern by the stronger, and in actual practice the control of such distribution in a given locality is almost invariably found in the hands of a single concern. This is true without regard to the source of the power. A system for distributing power from a fuel-power plant is not different in this respect from that for a water-power plant. An individual consumer of power rarely has access to the service of more than one power concern.

In the case of water power, these monopolistic tendencies are increased because of factors peculiar to that industry.

From a strictly technical or engineering standpoint, apart from all other considerations, it is probable that the most economical and efficient utilization of water-power resources can be attained only under a high degree of unified control of the water powers in large areas, and by linking together the power markets to which they are

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tributary. The existing facts already presented in this report as to concentration of water powers and related industries confirm this view. The superior efficiency gained by unified control rests on two main factors, as follows:

(*a*) "*Coupling up.*"—The advantages of "coupling up" have already been described in detail (p. 90), both in uniting adjacent water powers and in tying together adjacent power markets, so as to obtain the nearest possible approach both to a steady level of supply and to a steady level of demand. Obviously, a power system that can use a number of different power sites to supplement and aid each other, and that also can, by control of the market, more or less adjust demand to the variations in supply, will most efficiently utilize this resource, from a technical or engineering standpoint. In other words, the power can be produced and delivered for use at a lower average cost per unit in this manner, and with less waste.

(*b*) *Unification of storage.*—Unified control of storage development on a given stream is also obviously essential to the highest economic advantage. The water gathered in reservoirs on the headwaters of a stream contributes to every power site below them. The more of the power sites along that river system controlled by a single owner, the more inducement he has to develop storage at its head. On the other hand, if he controls only one out of a number of important sites thereon, he will receive only part of the benefit of any storage development which he may make at his own expense; and he will, of course, have far less inducement to make such development.

Conclusive proof that these concentration forces are now operating effectively on water powers is contained in the existing concentration, already described in this report.

Again, there are advantages inherent in the power site itself which tend toward monopoly. It is evident that as a rule water power must have a relatively low generating cost in order to be used at all in competition with fuel power, because water power in most cases has to bear the expense of transmission to the consuming market. This advantage of lower generating costs derived from the possession of the water-power site may be so great, despite the added cost of transmission, as to enable a water-power concern to dominate the distribution of power in a local market. Thus, even though a fuel-power concern may have its distributing system installed, its cost of generation may be so much greater that it can not afford to risk a conflict, but instead may virtually be forced to sell out or pass under the control of the water-power company. It is true that the water-power company may not be able by itself to supply the entire demand in a given market, but because of the advantage in generating cost it is more likely to dominate the situation than is a fuel-power concern.

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The important fact for this report is that such a concentrated control of the power source and distributing system is peculiarly likely to take place in connection with water power. The factors of "coupling up," of unification of storage, of natural advantage of water-power sites, as already stated, all work strongly toward concentration in the water-power industry. Furthermore, commercial water-power development requires a relatively large investment of capital in dam, power house, and transmission lines.

The result is that concentration of capital and of control of the power industry in a given marketing area tends to gather around water-power developments more than around fuel-power developments. The history of the power situation, as set forth in the earlier chapters of this report, in areas where water power is an important factor—as, for example, on the Pacific coast—well demonstrates this fact. The water-power industry, by its very nature, tends peculiarly toward concentration, unified operation, and monopolistic control of the resource itself. Nor is this all. Such concentration tends to draw toward water-power interests the control of great distributing systems. This makes it by so much the more unlikely, as above pointed out, that there will be permanent competition from fuel power in the commercial power business in an area with strong water power. The water power in that area may not be able by itself to supply the entire demand for power; but the water-power interests, through the peculiar concentration forces in water power, are more likely to control the distributing systems there. Furthermore, the fact that in water power the additional cost of auxiliary steam development is relatively low in comparison with the initial investment often enables the water-power owner to add fuel-power plants under conditions that would not be profitable for a purely fuel-power concern. Thus, the logical process is for the water-power interests to add also under their own control auxiliary fuel power to supply the gap in the demand, and thus gradually build up a complete monopoly in power in a given area, so far as commercial power is concerned. Such, indeed, are the existing facts in a number of communities and areas.

It thus finally appears that the great concentration movement this report has shown in connection with water powers, transmission and distributing systems, and related industries has a very important bearing on the question of power monopoly and the public interest.

In so far as monopolistic power is created by these broad forces, and in so far as the benefits of a public resource become by this concentration process, or, indeed, by any other method, the private property of a few, some effective policy of public control is imperatively necessary for the protection of consumers and the preservation of the rights of the public in that resource.

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It is true that the larger consumers of power have a considerable measure of protection against excessive charges or other monopolistic abuses because of the comparative ease with which they can generate their own power from fuel. The great number of small users of power, however—for instance, those using it for domestic purposes in the form of electricity—as well as those industrial concerns whose requirements do not permit them to generate fuel power at a reasonable cost, obviously have no such means of protection. Therefore, the protection of the interests of these classes of consumers requires some form of public action as to the prices of power.

IMPRACTICABILITY OF REGULATION OF PRICE OF WATER POWER INDEPENDENTLY OF PRICE OF FUEL POWER.—It is outside the scope of this report to discuss the question of regulating the price of power generally. As this is a report simply on water power, it is sufficient to point out here the utter impracticability of any effective plan for the regulation of the price of water power as distinct from the price of commercial power in general.

Power, whether the product of the water wheel or of the steam engine, is absolutely identical. It is not feasible to apply to water power a policy of price regulation which is not likewise applied to power derived from other sources. Water power can not be thus separately treated. The reason for this is that, in practice, the price of water power will almost invariably be substantially the same as the price of fuel power.

So far as the larger consumers of power are concerned, these, as just stated, can construct their own steam plants, buy their fuel in the open market, and produce their power themselves. Broadly speaking, fuel is always obtainable. It follows that the market price of power, whether water or steam, to these larger users, in a given community, can not greatly exceed the cost of producing power at that point from fuel. On the other hand, both theory and practical experience indicate that the price of water power will not be materially less than the fuel-power price. It might be less if the supply of water power were greater than the market could consume at that price. This, however, rarely happens. On the contrary, the Bureau's investigation indicates that in no considerable place or area in the United States is the whole demand for power supplied from water. In other words, in a given area the demand for power almost invariably exceeds the quantity which can be supplied from water. The owner of water power, therefore, has no occasion, except for the purpose of temporarily effecting an entrance into a market, to reduce his price substantially below the prevailing price for fuel power.

Likewise, of course, in the case of the large body of smaller users of power, owing to the fact that the supply of water power in a given

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area almost invariably is less than the demand, there is no permanent inducement for a water-power company to sell its product at materially less than the price which could be obtained by a commercial fuel-power concern.

Therefore, although water power can often be generated and distributed at a much lower cost than fuel power, nevertheless it would be impracticable to fix the price of water power below the prevailing price of fuel power. Since the supply of water power is not equal to the demand for power, such a policy would simply result in reducing the price for a part of the power supply and not for the whole. This in turn would mean that certain consumers of power—those getting water power at the price fixed by law—would get their power at lower prices than others.

An example will best illustrate the situation. Let it always be kept in mind that, broadly speaking, experience indicates that the demand for power in a given market area almost always exceeds the supply of water power alone. Suppose now, within that marketing area, a water-power company can produce energy at half the cost of steam power. It can not, however, supply the whole demand for power. Consequently some power consumers must still use fuel power. Assume that by law the water-power company is required to sell its power at half the price of fuel power prevailing at that time. This means that the consumers of fuel power in that area will have to pay twice as much for their power as those served by the water-power company. A practical result of this situation would be that the men who controlled the water-power company could organize corporations of their own to which they would sell their available water power at the low statutory rates. Thus they could secure the advantage of cheap power for themselves. But even if such a device were in some way prevented by law, and even if the water power were actually sold to outsiders at the reduced price as established by law, it still could be supplied to only a portion of the consuming public, since water power could not supply the whole demand for power. All outside this fortunate circle of water-power consumers would have to pay the fuel-power price. The benefits of water power, therefore, would merely be transferred from a group of water-power stockholders to a group of water-power buyers. No public end would be served by the transfer of such a privilege from one group to another.

Even if water power were publicly owned and operated, still the public price of water power could not be fixed independently of the price of fuel power. Any attempt to make the price of water power less than the price of fuel power would mean that, since some power users would still have to depend upon fuel power, there would be an

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arbitrary discrimination between them and those who were able to secure the public water-power service. Thus, even under public ownership and operation, the only equitable plan for price regulation would be to sell water power at substantially the same price as fuel power.

These considerations, therefore, clearly indicate that it is impracticable to consider the problem of regulating water-power prices as an entirely separate and distinct thing, regardless of the price of fuel power. Instead, any public regulation of the price of power must be applied equally to both water power and fuel power. It is not intended by this statement to deny the desirability of some public regulation of power prices. This, however, as above pointed out, is a matter outside the scope of this report, which is concerned with the water-power problem only.

Section 4. The power site the effective point for applying a public policy to water power itself.

The protection of the consumer of power from excessive or unfair power prices is one question. Quite another and distinct problem is the consideration of obtaining for the public as a whole its proper share in the advantages inherent in water powers. From what has been said it should be clear that the public can not hope to secure its share in the benefits of such public resources by establishing a lower price for water power than for fuel power.

In so far as power can be produced at a water-power site and delivered at consuming markets at a lower cost than fuel power, there is an advantage in favor of the water power which is the basis for the value of the water-power site. It is being more and more recognized that the public ought to assure to itself, so far as possible, its proper share in the values which, with the development of industry, attach to a water-power privilege.

The important fact which the Bureau desires to emphasize is that the only effective point at which this right of the public can be exercised is the natural resource itself, the power site. In so far as the public is still the owner of power sites, it is apparent that an effective water-power policy can be established by which the public can either itself develop such powers or control their development by private parties in such manner as to retain for the public its share of the benefits derived from the natural resource. If the power is developed by the public and sold at the price of fuel power, the public treasury will receive the difference between the delivered cost of the two kinds of power. If, on the other hand, the public permits private parties to develop and operate its water powers, it can charge a rental for that right which will also go into the public treasury.

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It is only through some such reservation, and through the operation of the one agency that represents the public, namely, the Government, whether State or Federal, that the advantages inherent in public water powers can be reserved for and distributed to the community as a whole. This consideration must, therefore, primarily dominate a public water-power policy.

In this connection it is important to point out that the value of a water-power site, considered by itself, is usually augmented because of the conditions under which the water-power industry is ordinarily conducted. Thus, the "coupling up" of several water-power sites under a unified control, and the accompanying relationships with power markets similarly subject to more or less concentration of control, already referred to, give to a group of water-power sites collectively a combined value considerably in excess of the aggregate of their values if operated independently. Consequently, this concentration presents a further important factor in the determination of a public policy with regard to water power. It increases the value of those natural advantages inherent in the power site, to which site public policy must give its main attention, and consequently should be taken into consideration in determining the compensation to which the public is properly entitled in allowing its water powers, or those in which it has an interest, to be developed by private parties.

The exact terms under which power privileges should be utilized can be determined only after careful examination of the subject in the light of what is alike fair to the public at large and to those investing in water-power development. Without attempting to indorse any particular policy with respect to the water powers on the public domain, it is proper to point out that a system of leasing presents decided advantages. This is particularly true because of the ease with which the public interest can be safeguarded by such a system. As the value of sites changes rental charges can be adjusted from time to time to conform to changed conditions. No fixed term for such leases could be suggested as suitable without considering other conditions of the contract and the nature of the enterprise itself. In any given case, the conditions of the lease, as well as the natural advantages of the water-power site and the business and profits expected, would naturally be reflected in the amount of the rental which those who undertook the enterprise would be willing to pay. Where the cost of developing and distributing water power may be about equal to the cost of producing and distributing fuel power, it would probably be a wise policy to lease sites without charge until such time as conditions would warrant compensation to the Government. Otherwise, such water powers could not be developed at present.

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For water powers owned by the public, the leasing system thus furnishes not only the means of obtaining the full present value of the site, but also, under suitable arrangement of the terms of the lease, the means of receiving from time to time increased compensation for increases in the value of such natural resources. It has the final advantage of retaining in the public the ultimate control of the resource. Under exceptional circumstances the outright sale of power privileges might be the only method that would induce development. The parting of title to water powers by the Government and the consequent relinquishment of the strongest element of control should not be resorted to, however, until it is certain that the public interest is thereby best conserved. The safeguarding of the more distant future is especially desirable, because water power, broadly speaking, is a resource of inexhaustible character and because of the incompleteness of our knowledge as to future conditions and possibilities in the hydroelectric industry.

With respect to the water powers which are now held in private ownership, regulation and control can be applied only through taxation of the values of sites, or the exercise of eminent domain (with, of course, due compensation to the private owners for the present market value of their interests therein). The regulation of prices charged by such private water-power concerns, however, is a matter still within the control of the public, but to be effective it must be a part of a system of regulating power prices generally, as explained in the preceding section.

Whatever method of control over water-power resources may be deemed most equitable and expedient, it is imperative that a definite policy by both the Federal Government and the States be promptly adopted, in view of the strong present tendencies toward acquisition and concentration in private hands, as described at length in this report.

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